Dynamic Fault Injection Library Approach for SystemC AMS

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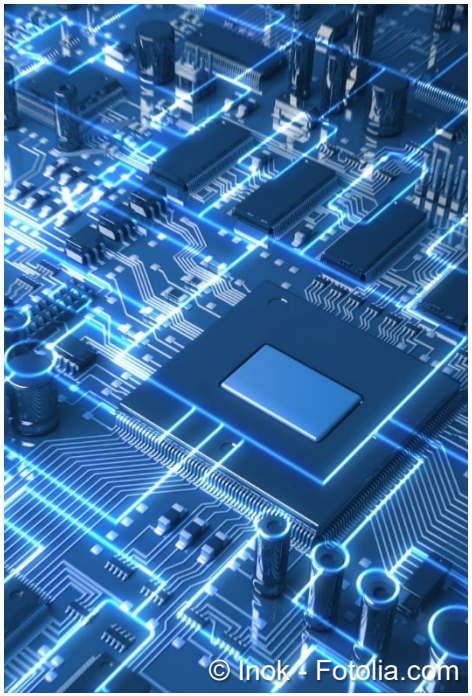
Cross-domain system level modelling



- Exploration and validation of the overall system
- Concept engineering support and system level verification
- Combined simulation HW (an.+dig.), SW and non-electrical environment
  - Trade-off: high performance and model accuracy

SystemC/ SystemC AMS

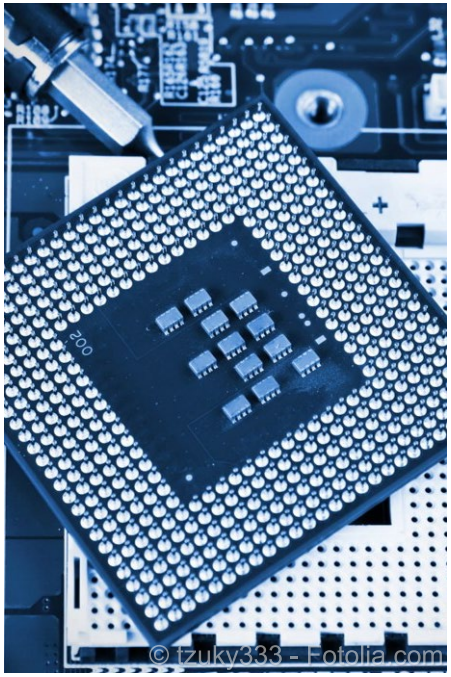
is the solution!

firmware development

development

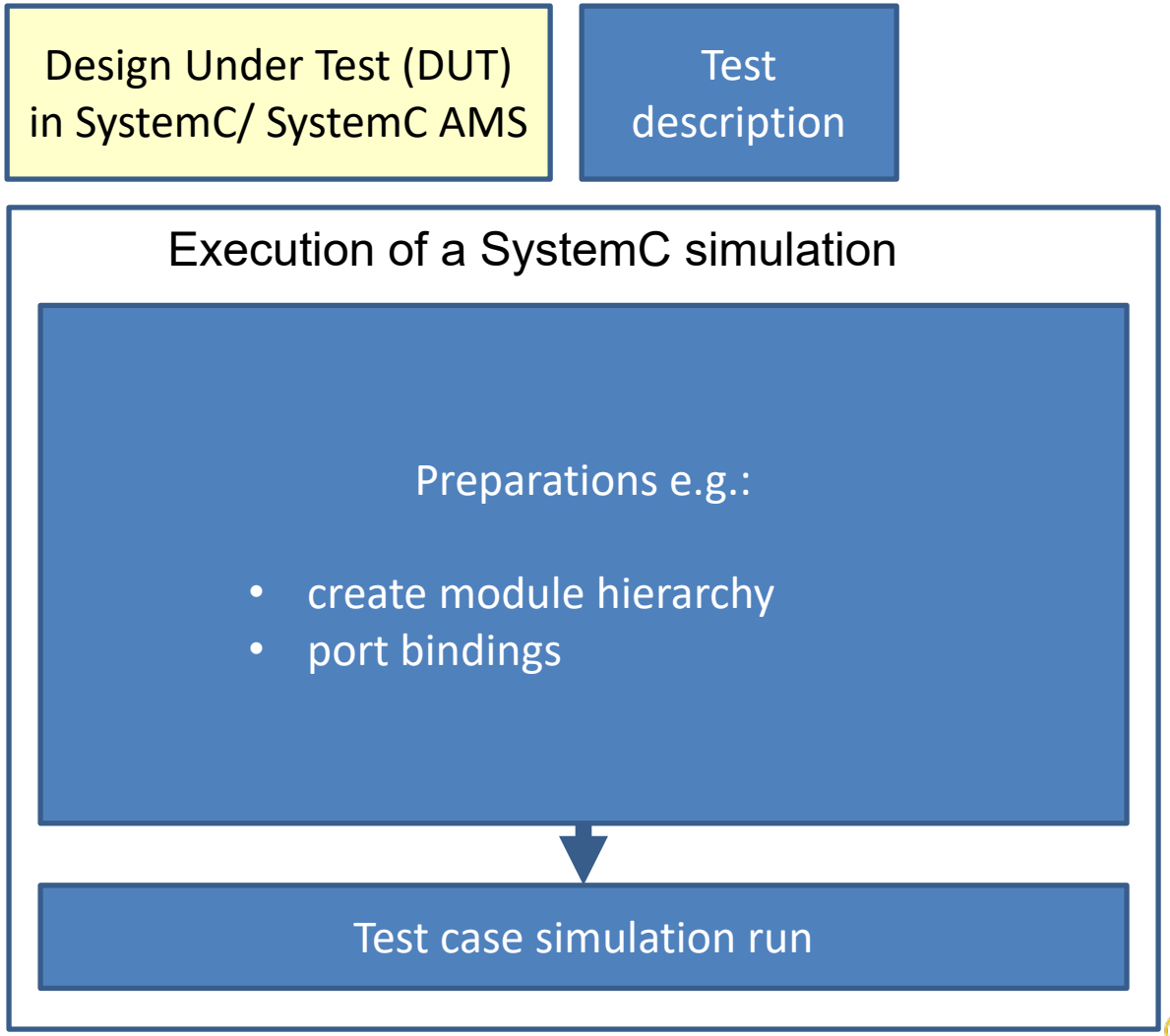
Ensuring functional safety

- Safety integrity verification by fault simulation
- Checking correct and complete implementation of technical safety requirements (ASIL)

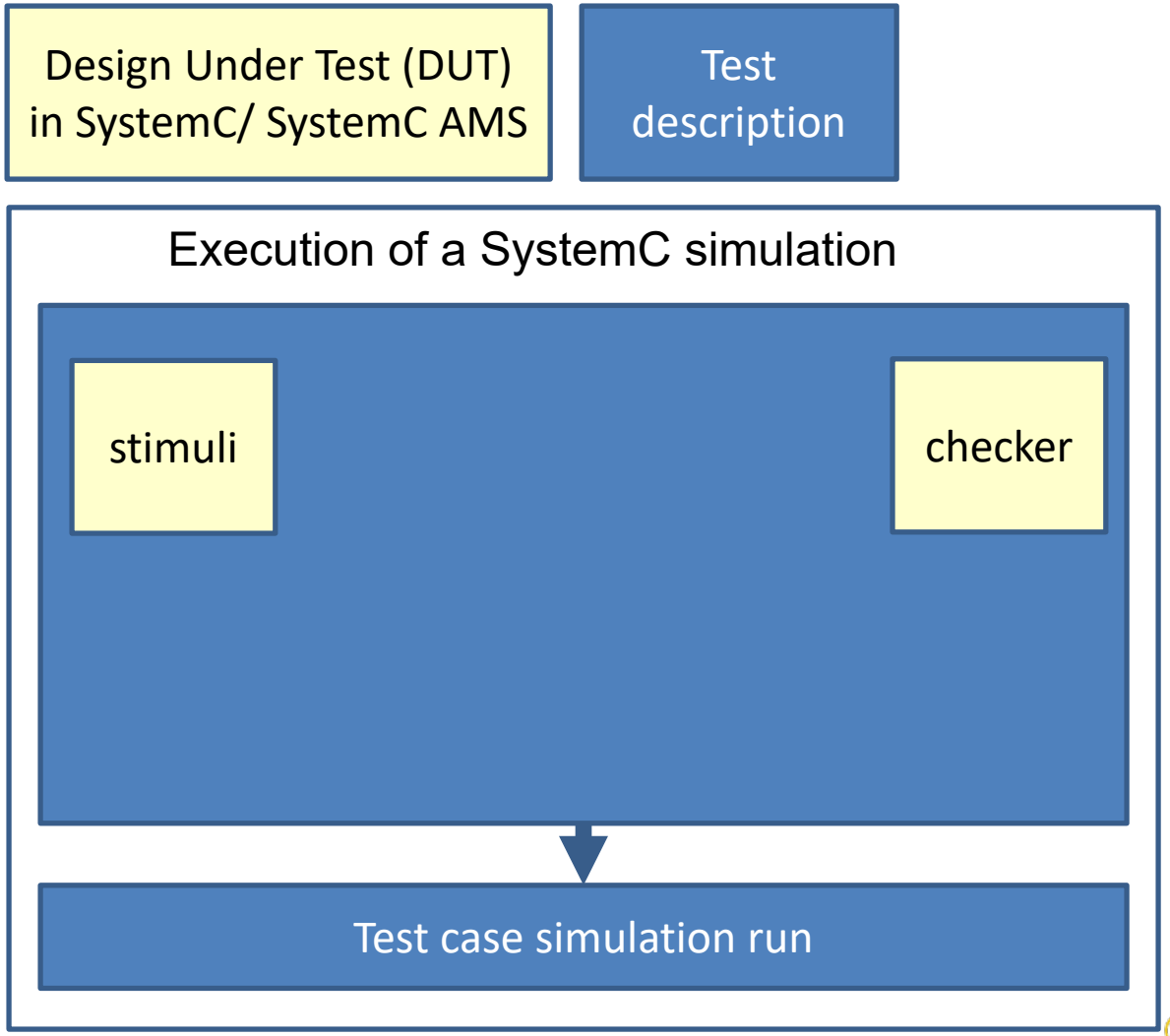


- Improvement of diagnostic coverage and design robustness
- State of the art: fault injection by direct integration
- Introduced: Approach for dynamical fault injections for SystemC AMS

Dynamical Fault Injection approach

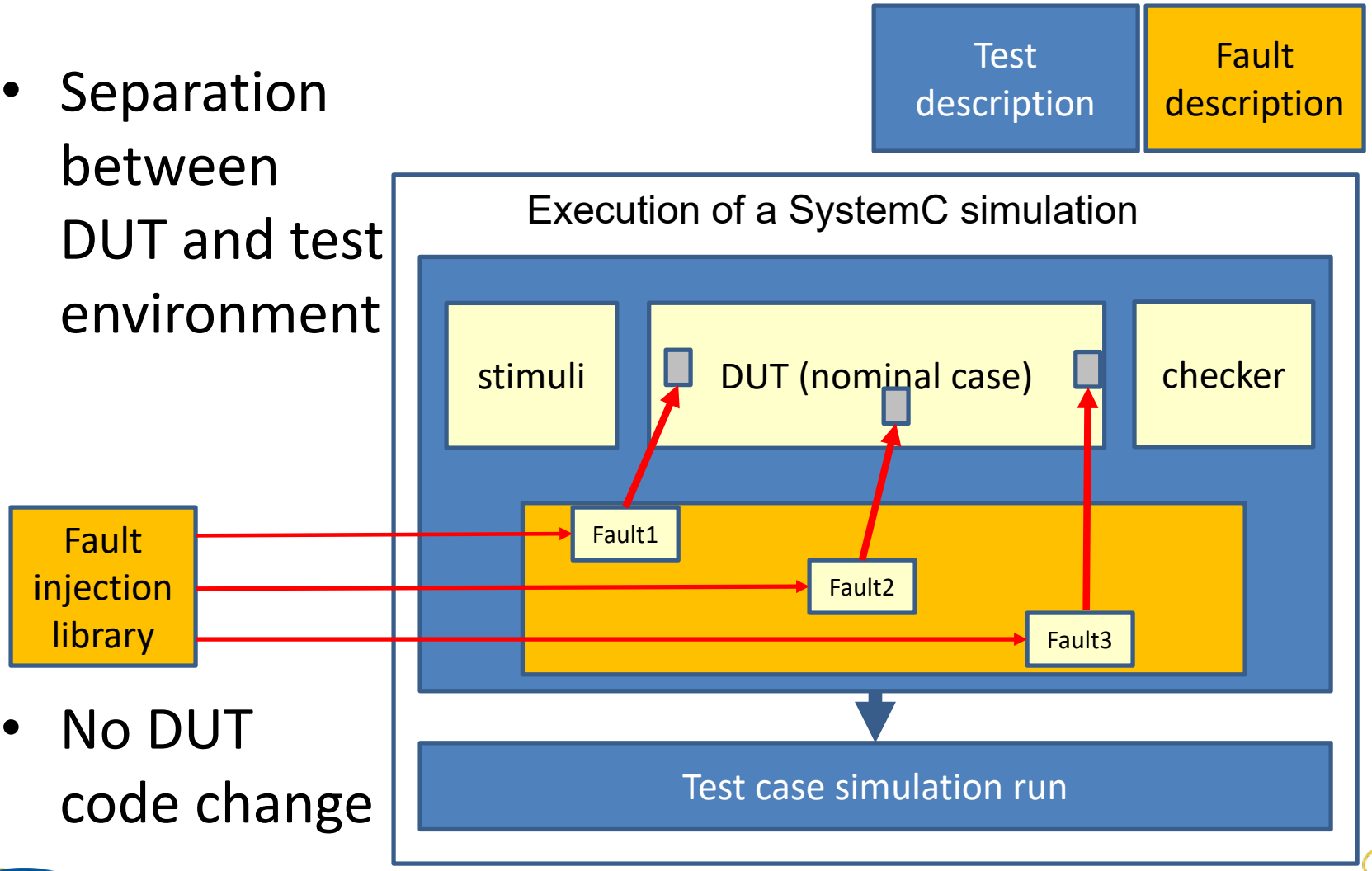


Dynamical Fault Injection approach



Dynamical Fault Injection approach

- Separation between DUT and test environment
- No DUT code change

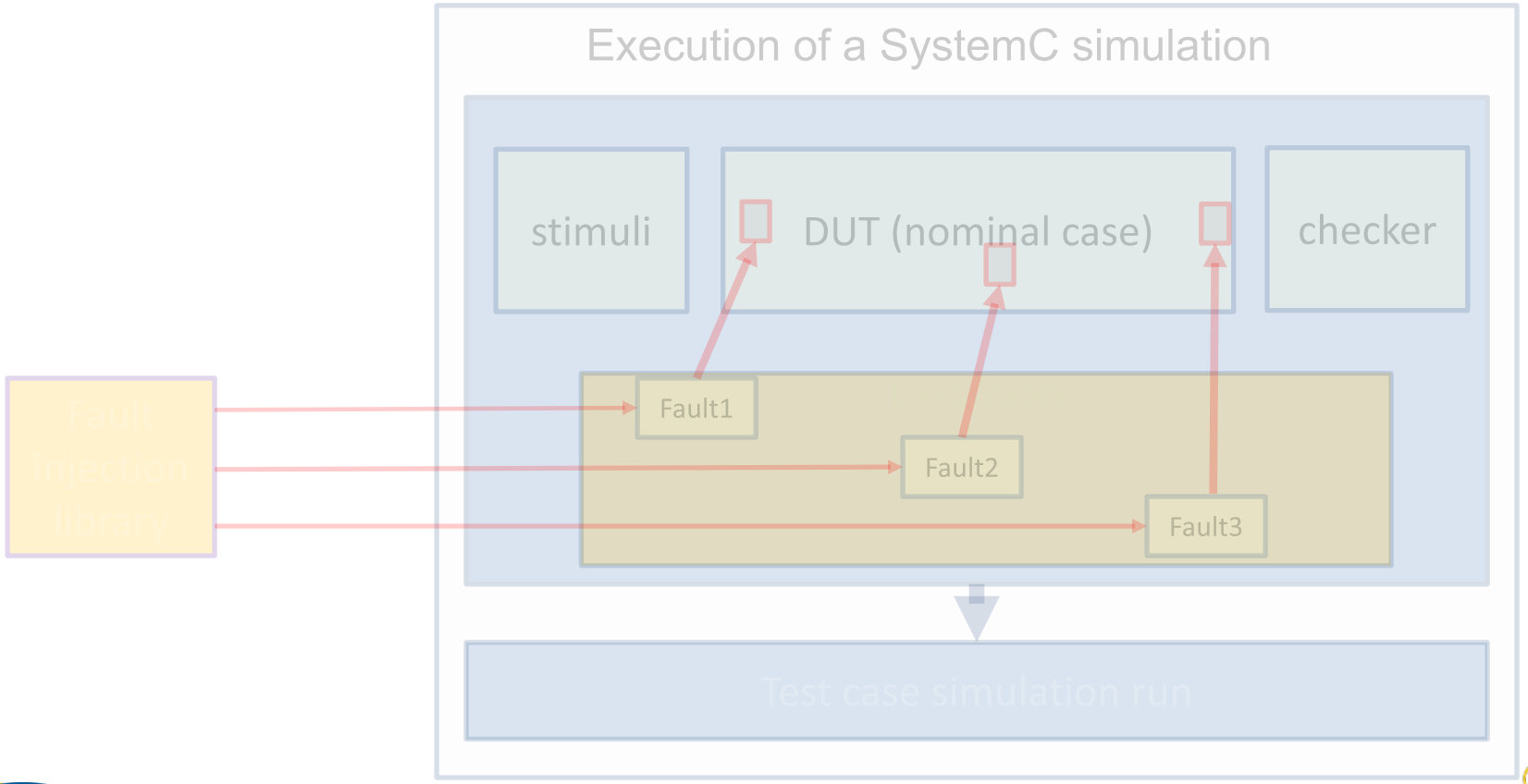


Dynamical Fault Injection approach

- How to create fault descriptions?

Test description

Fault description

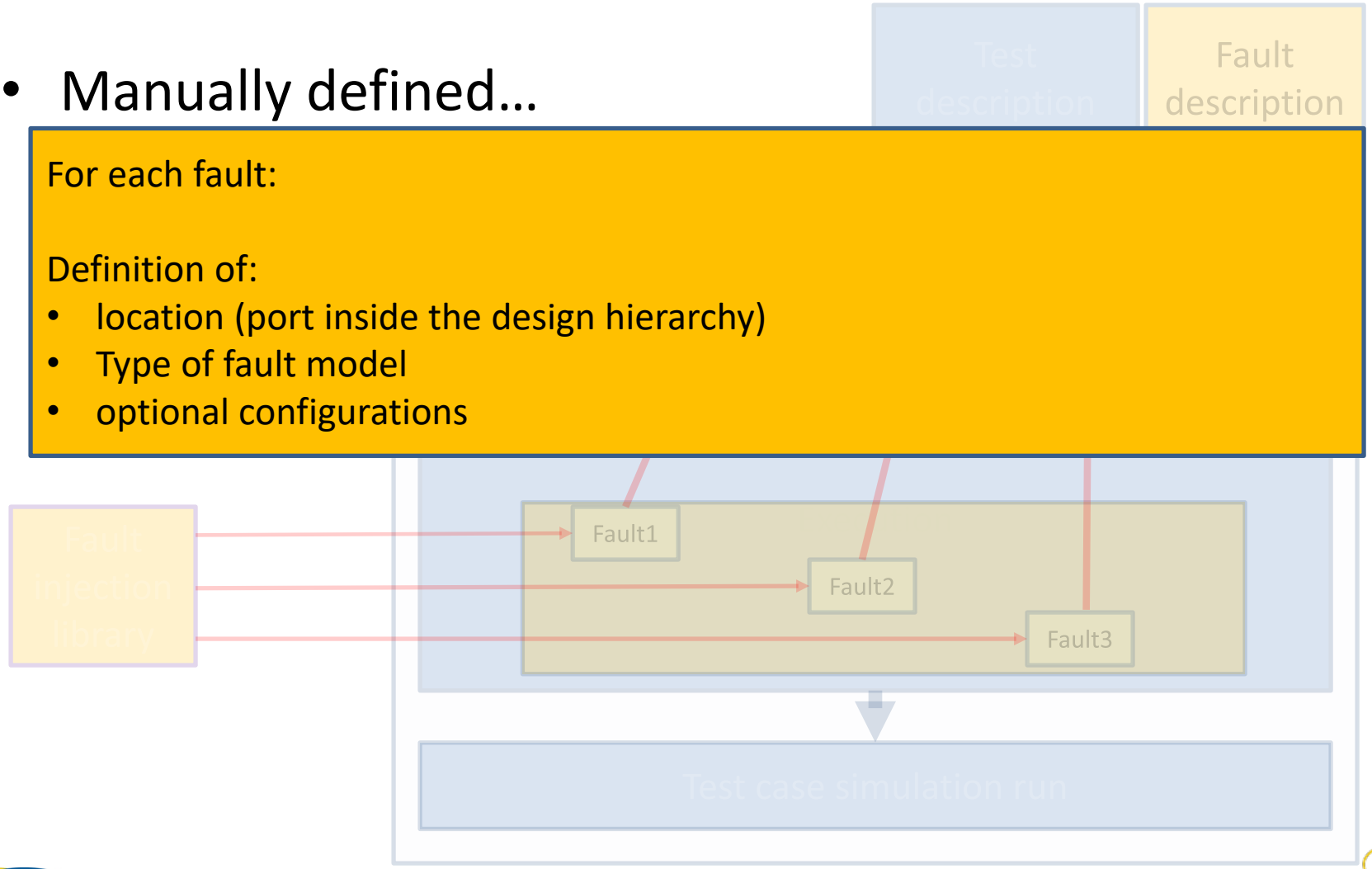


Fault descriptions:

- Manually defined…

For each fault:

Definition of:
- location (port inside the design hierarchy)
- Type of fault model
- optional configurations



Fault descriptions:

- Manually defined…

For each fault:

Definition of:
- location (port inside the design hierarchy)
- Type of fault model
- optional configurations

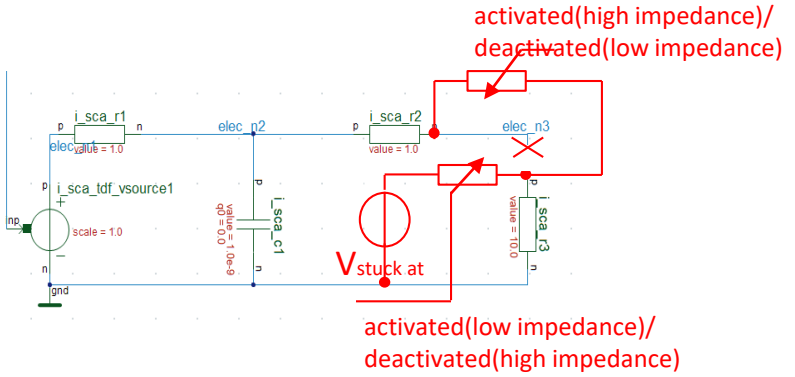
- …or alternatively:

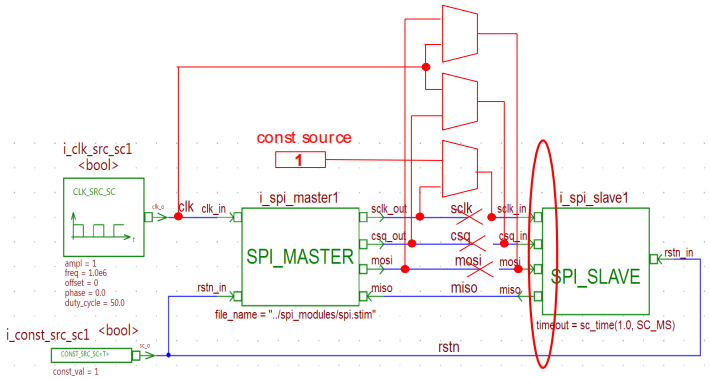
Definition of used fault type, and…

…scanning Design hierarchy e.g. for:
- Naming conventions
- Port MoC
- Port type

Fault injection library structure

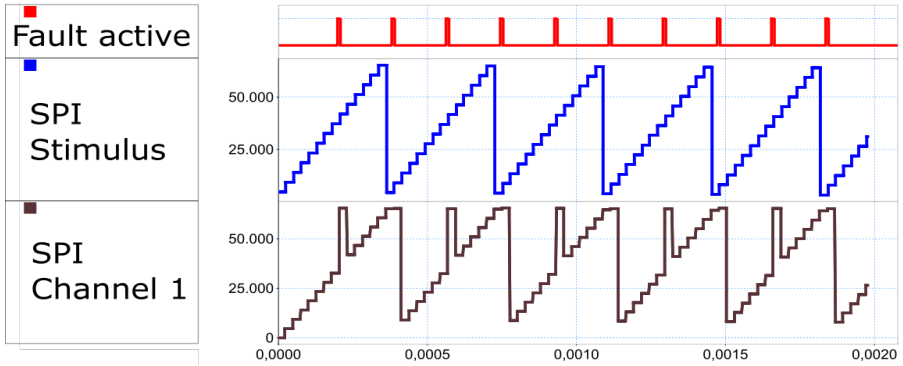
- Low level failure structures depend on MoC
- Established fault models
  - (stuck-at, crosstalk, open/short, delay, bridge, glitch)
- Scenarios





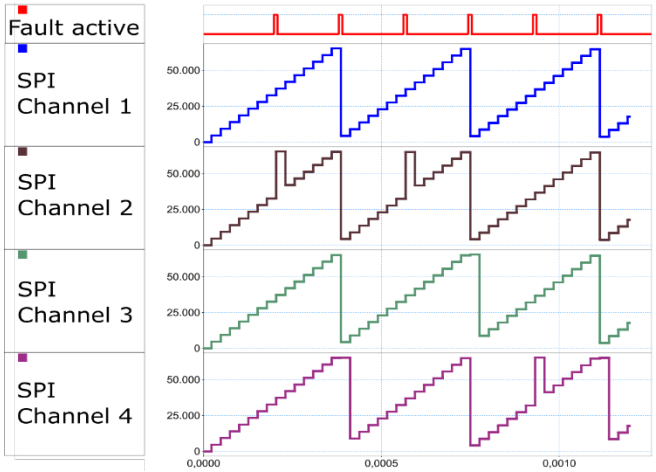
Fault occurrence configuration

- Periodical

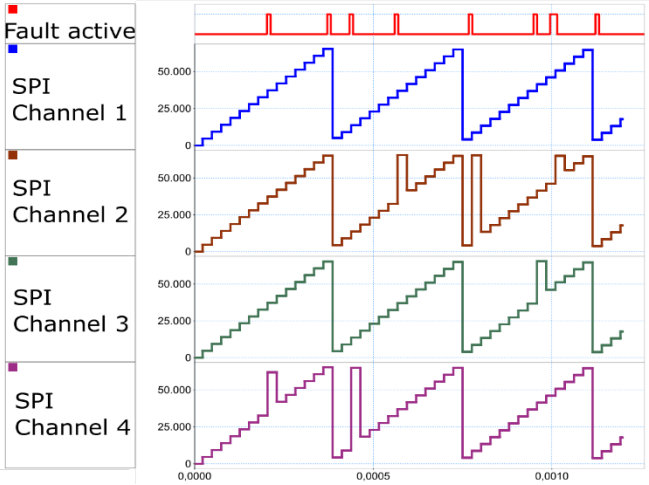


- Statistical variations of …

…location

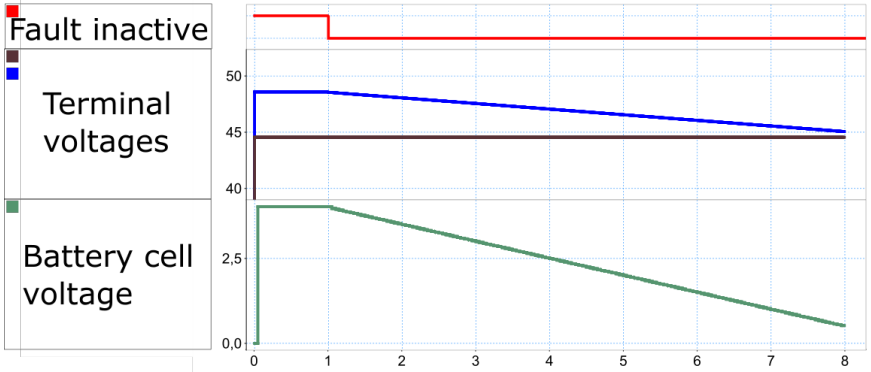


…time

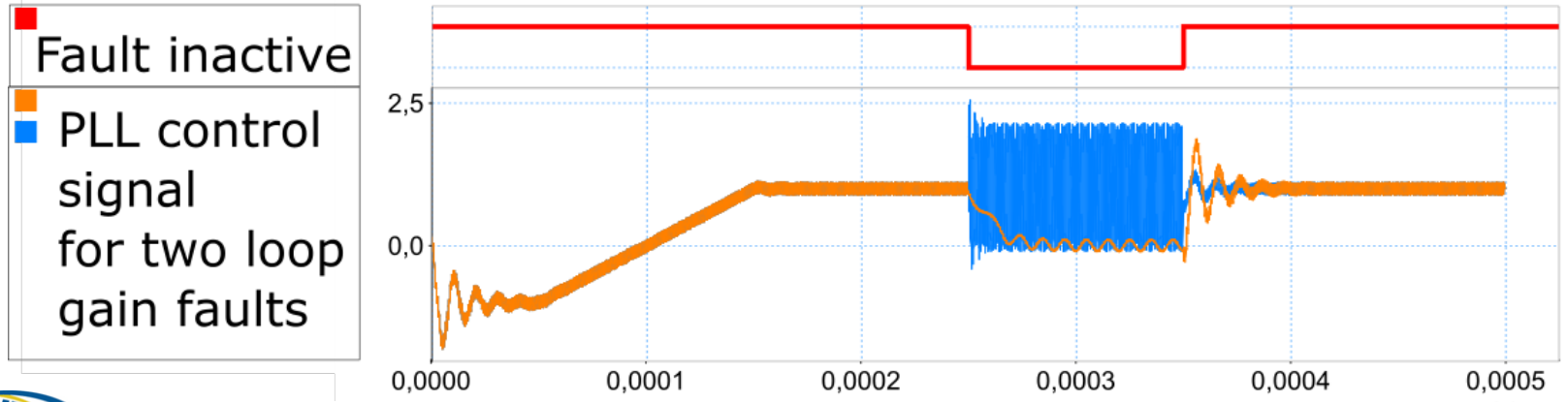


Fault value configuration

- Continuous value sweep

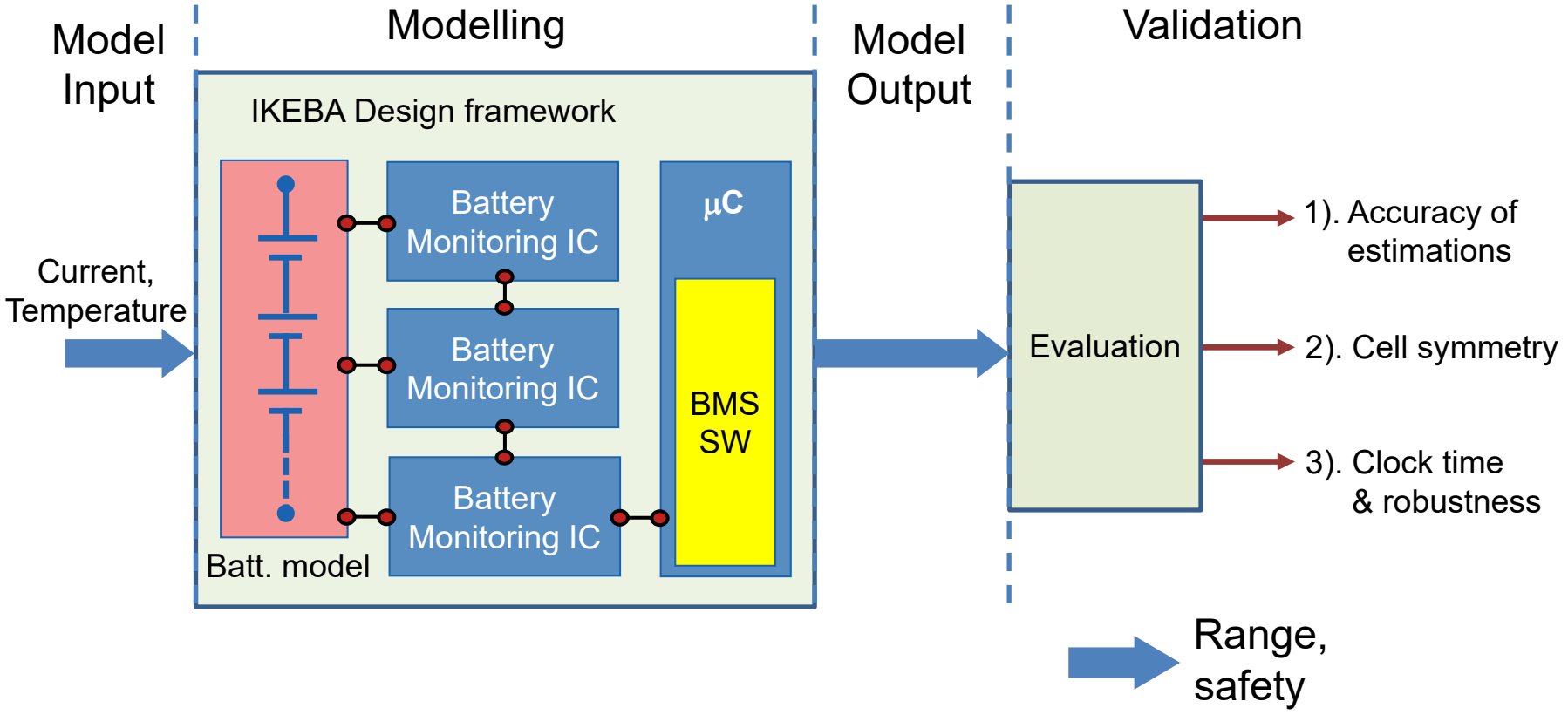


- Sequence of simulations (fault parameter sweep)

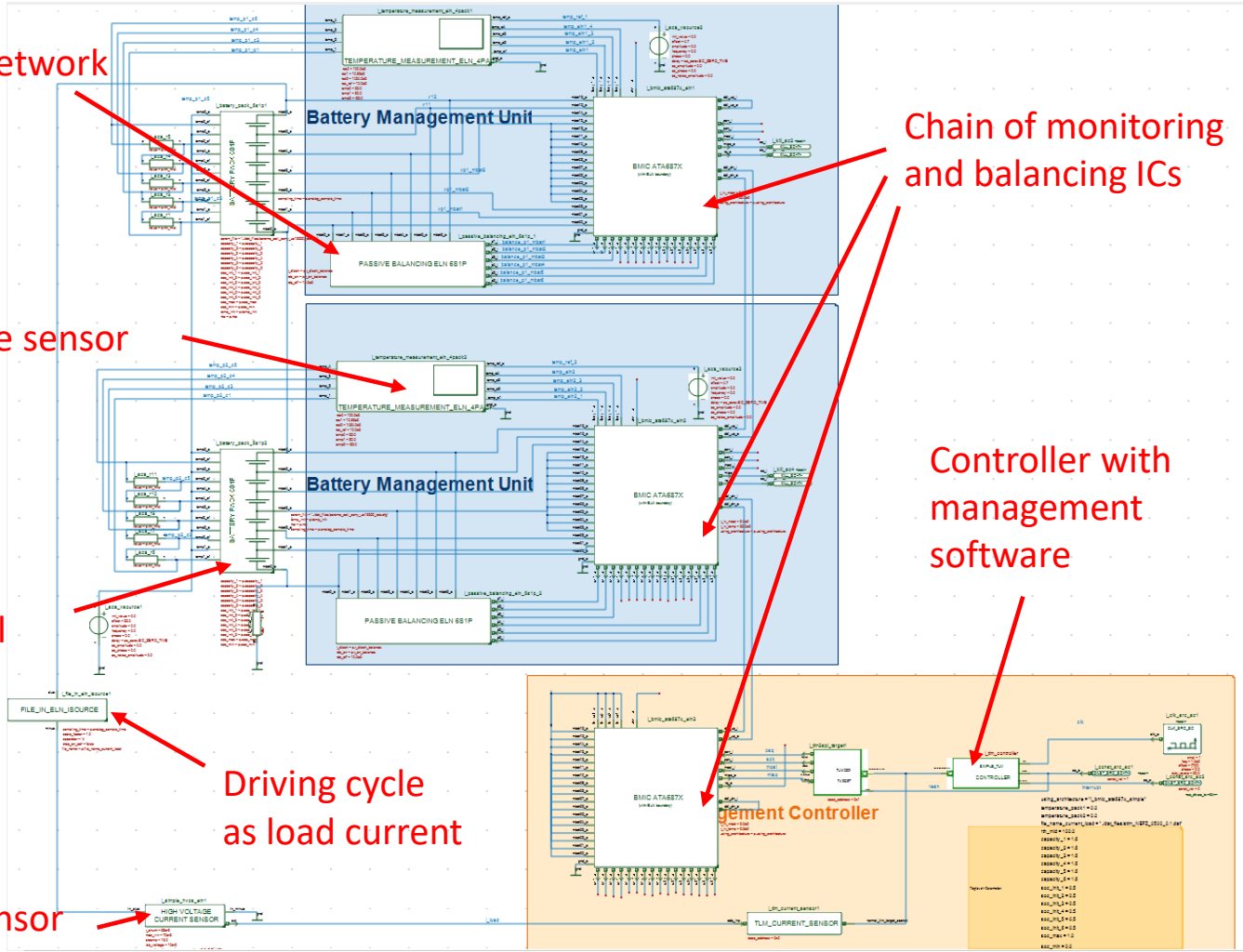


Battery management application (IKEBA)

- Functional validation - nominal

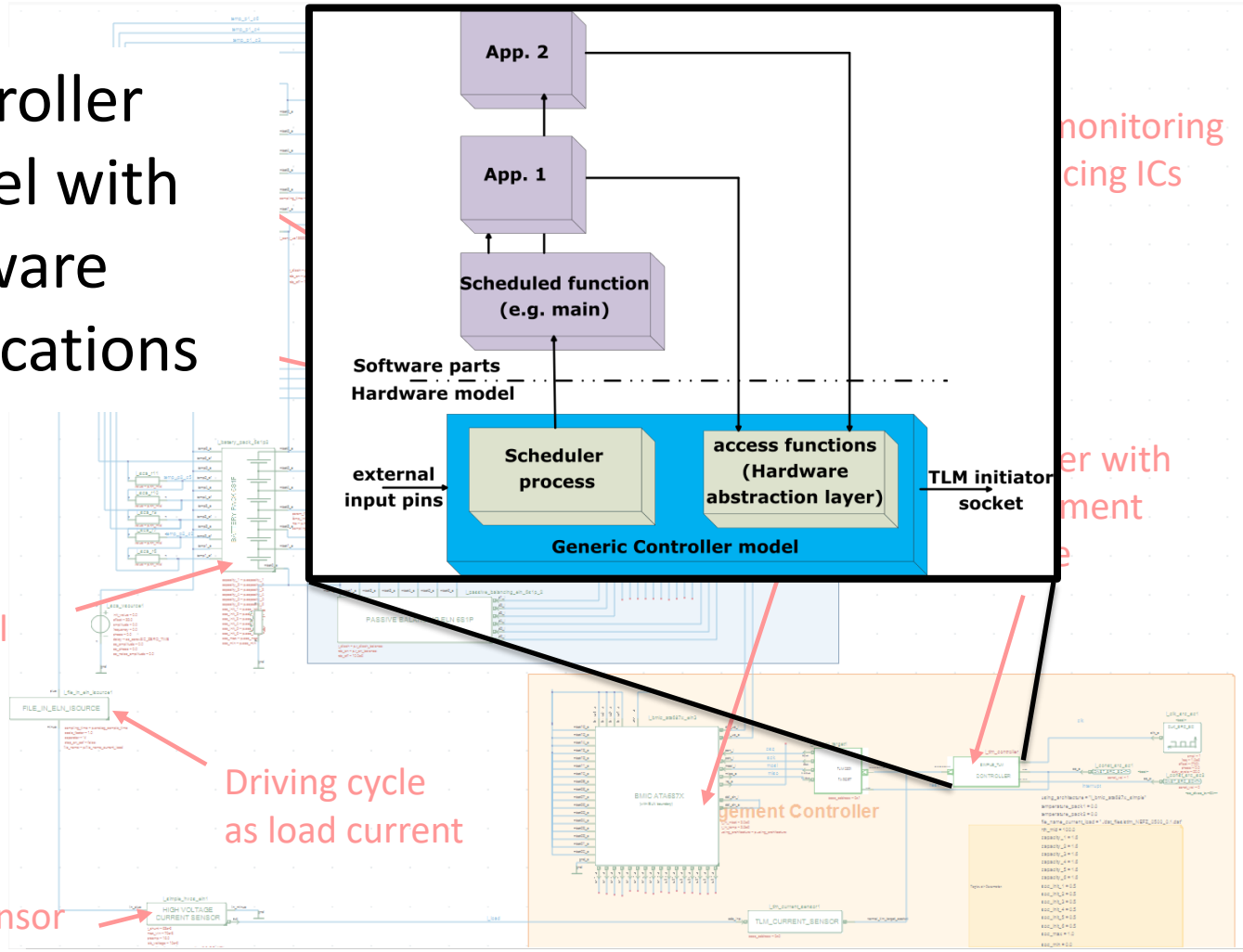


Battery management application



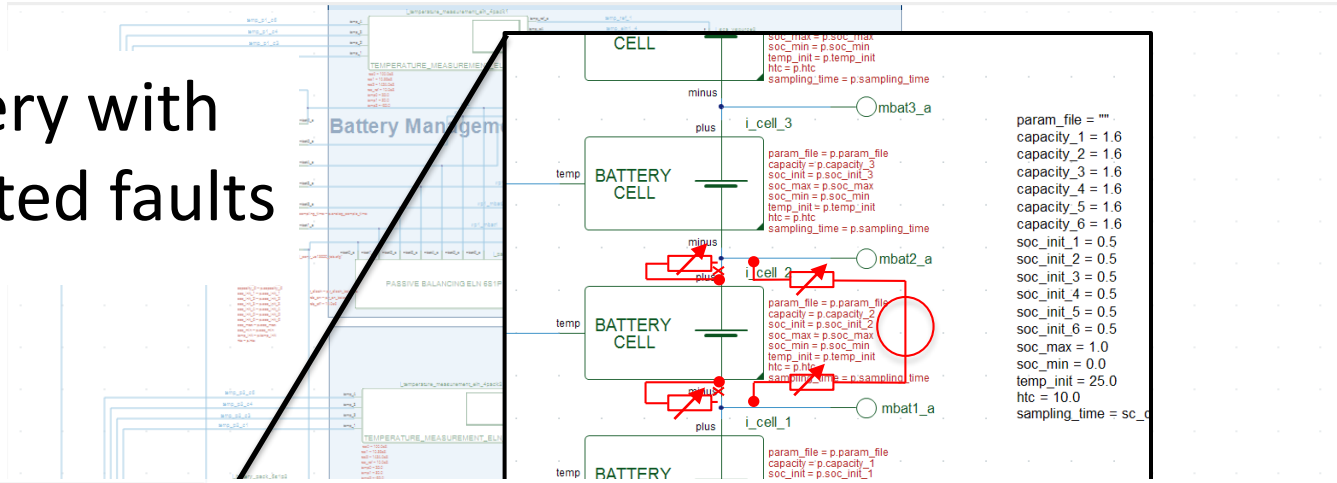
Battery management application

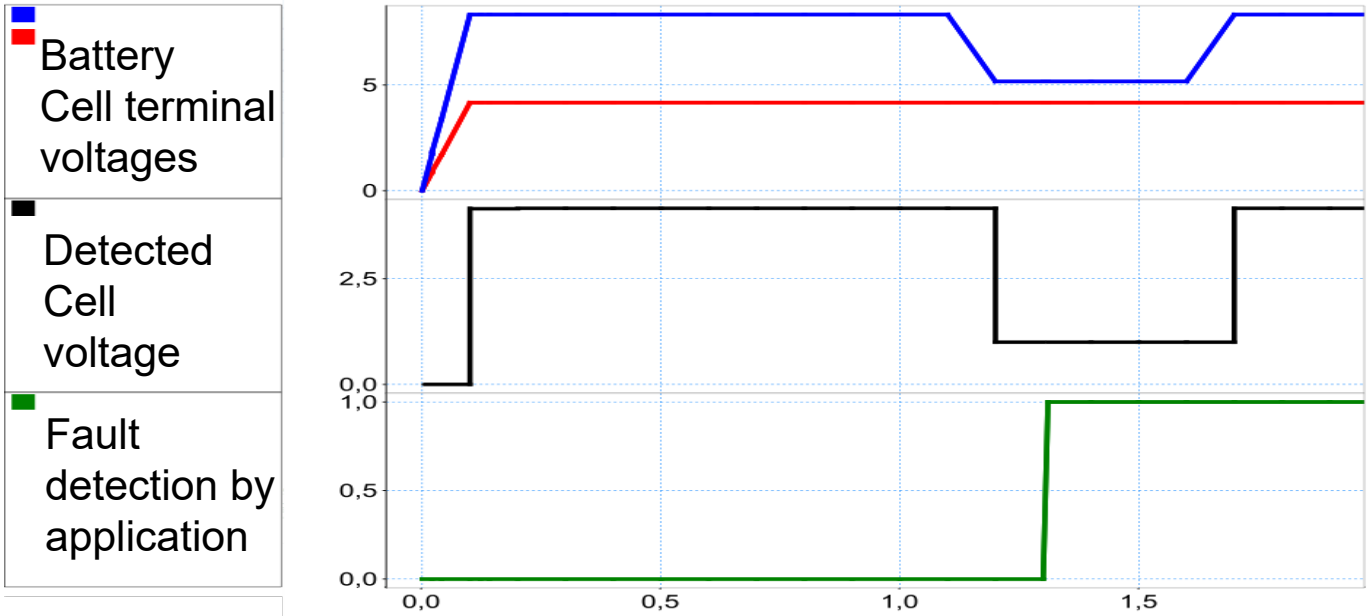
- Controller model with software applications



Investigation of battery faults

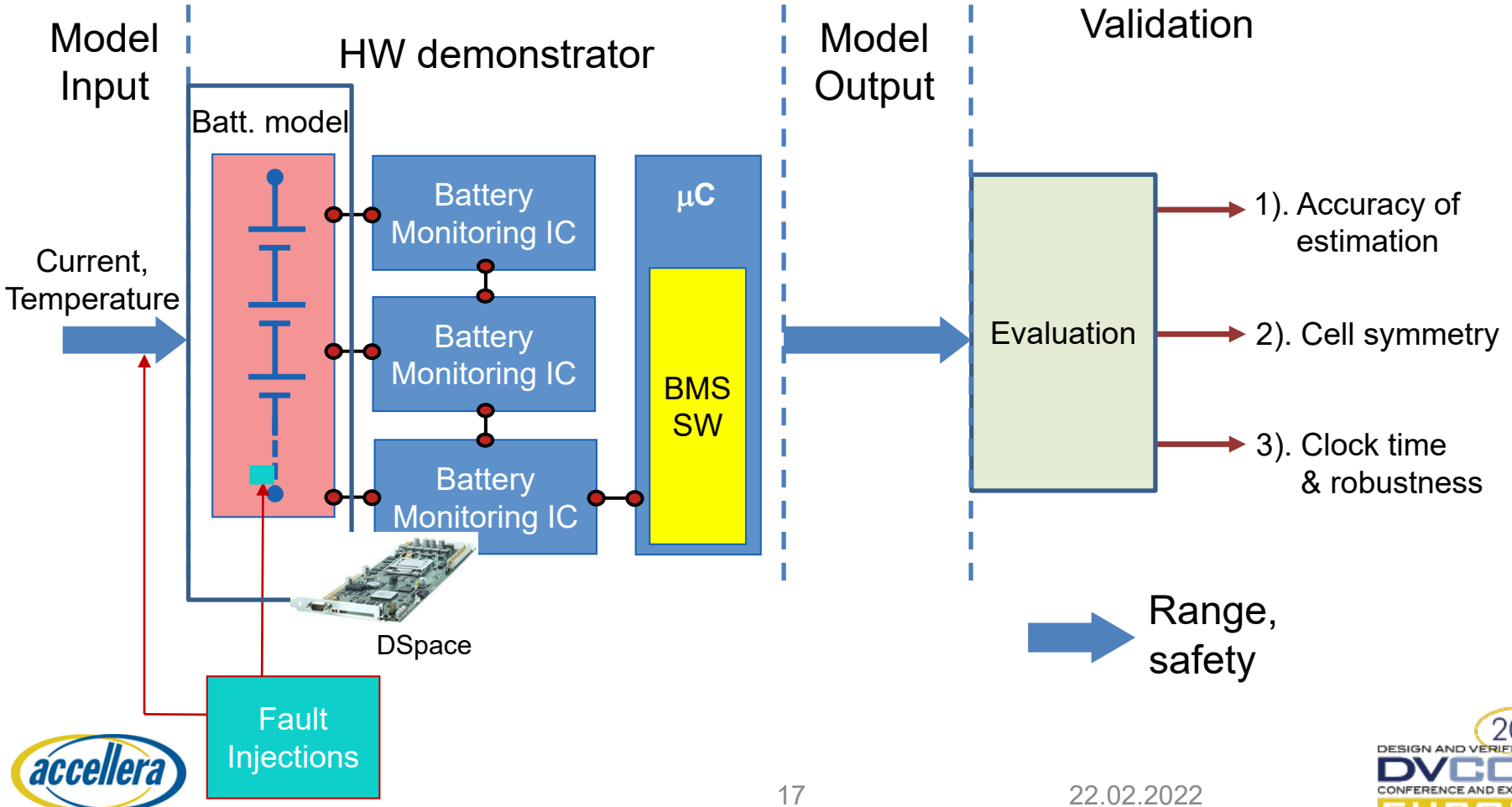
- Battery with injected faults



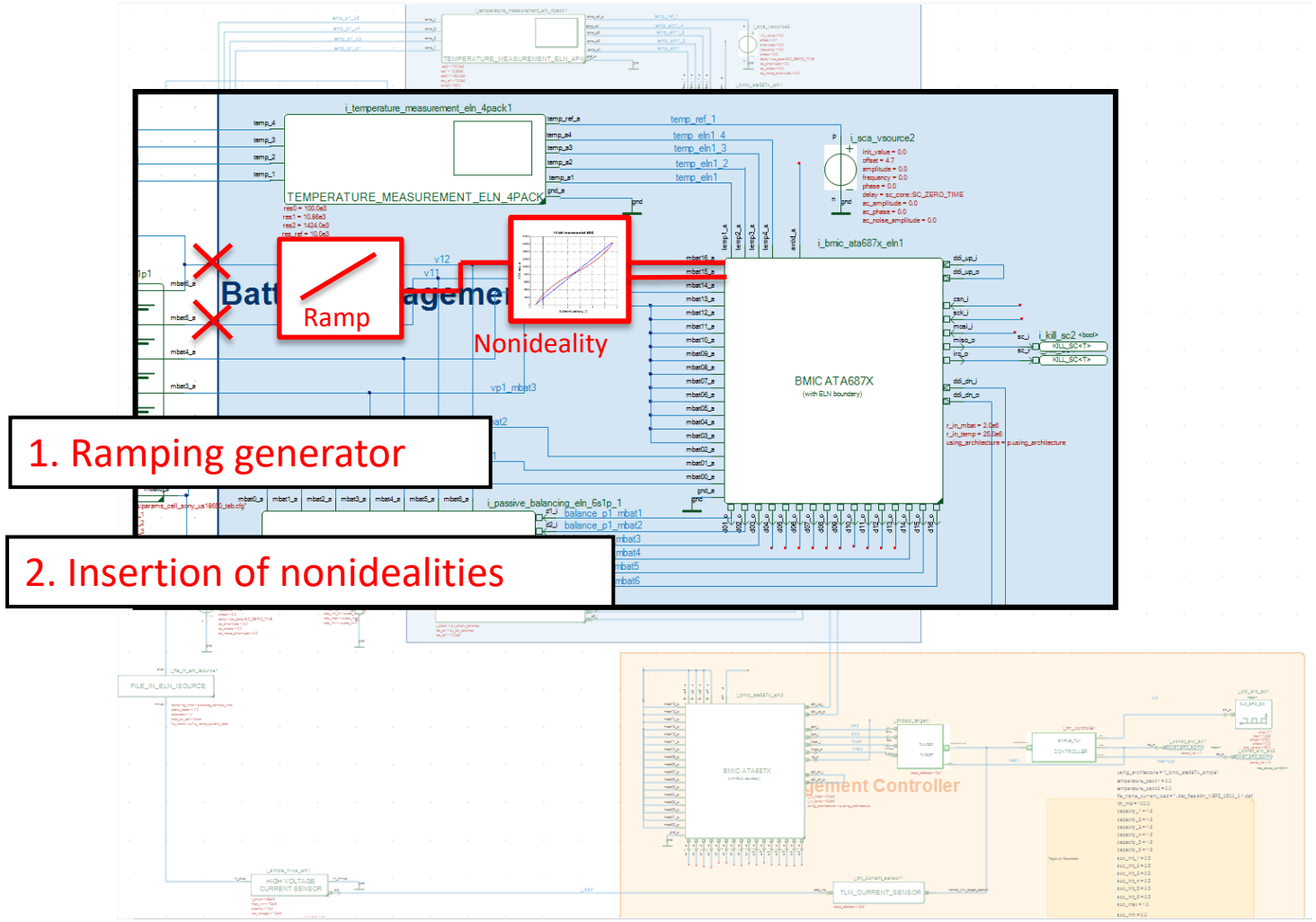


Battery management application (IKEBA)

- Functional validation - HiL



Approach used as stimulus generator



Conclusion

- Dynamical fault injection approach
  - Clear separation between DUT and test environment
  - Avoids code changes in the DUT
  - Prepared and user defined fault models
  - Applicable in real-time systems (HiL)
- Usage as in-depth stimulus generator possible
  - Further investigation in process
  - Enables new testbench concepts
- Wide range of investigation on system level enabled
  - Diagnostic coverage improvement
  - Software testing
  - Variation testing

Outlook

- Increase user friendliness
  - Automatical generation of the fault injection stimulus model (requirement management tools)
  - Alternative GUI-based approach

- Extensions of available fault models

Questions ?

What is the injection approach in details?

- SystemC callback used: *before_end_of_elaboration*
- Searching in design hierarchy for target port
- reconnecting port
- Instantiate and insert failure structure