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ENERGY

Power Cybernetics – the future of validation

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SMART TRANSMISSION AND DISTRIBUTION NETWORKS
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We are a global classification, certification, technical assurance and advisory company

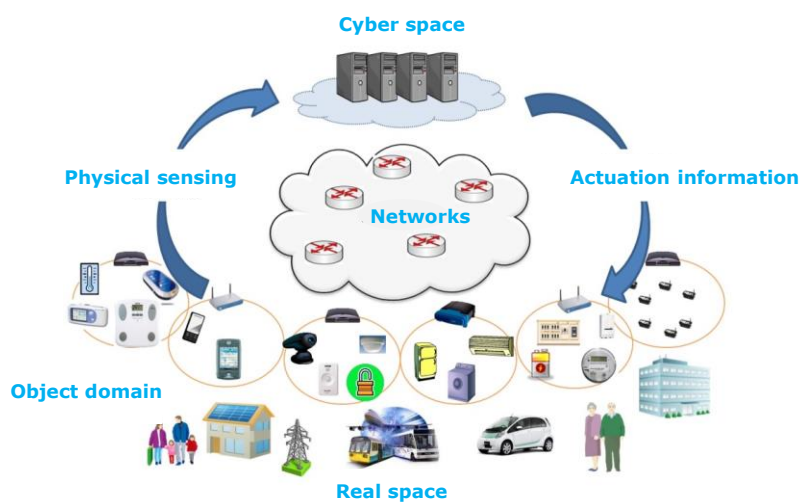
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Grids become cyber physical systems ...



... with increased uncertainty about:



human behaviour



reliable electricity supply



(cyber) vulnerability



new technology



**How to ensure safe and reliable
system operations amongst this
increased complexity ?**

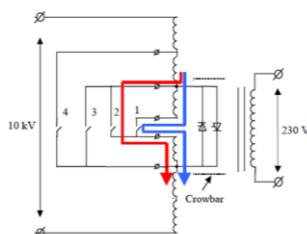
To note:

Validation (testing) is done in order to de-risk

***a component, system or technology
for its intended purpose
in a 'risk-free' environment,
before installing it in the real world.***

A story of smart transformers in a greenhouse area

- Fully tested at KEMA (now DNV GL), including short circuit
- Installed in greenhouse area in western part of The Netherlands to improve the power quality
- Functioned perfectly, until a second unit was installed nearby
- Started to react on each-other resulting in instability
- Removed from the grid



Power Cybernetics - the future of validation

Component testing:

- Individual performance validation
- Certification on component level
- General application information
- = 'complies to standard'



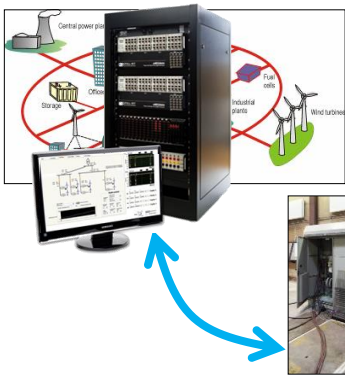
System testing:

- System performance validation
- Validation on system level (>1 component)
- Specific application information
- Interaction verification
- Dynamic behaviour
- = 'Fit for Purpose'

**Hardware in the loop testing
promises to do this**



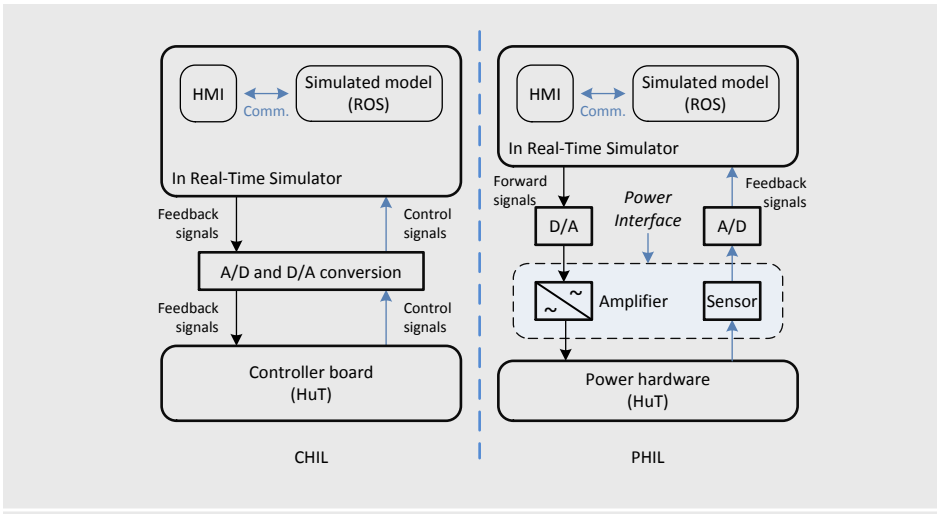
What is hardware-in-the-loop testing?



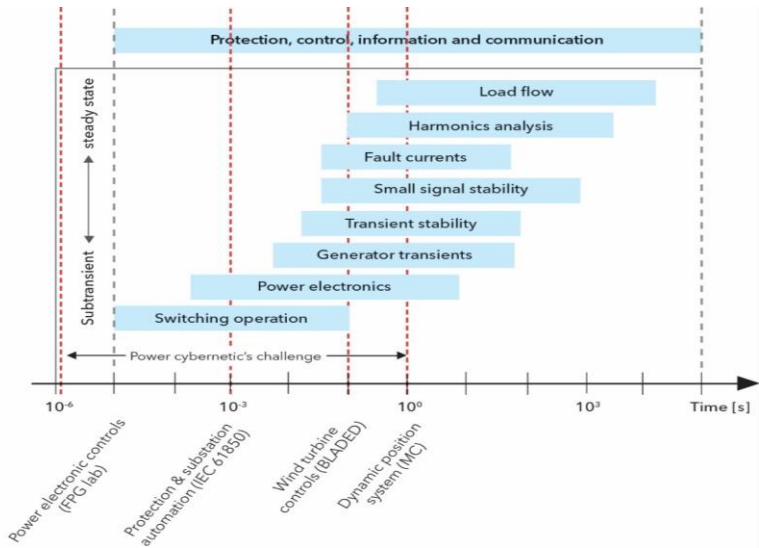
- Dynamic behaviour
- Interaction analysis
- Fault ride-through, etc.
- Test systems beyond the physical limitations of a laboratory






Power Cybernetics CHIL and PHIL



Power Cybernetics – the stability challenge

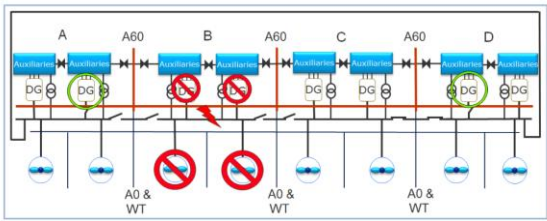


Project – Close bus-tie relay testing for DP vessels



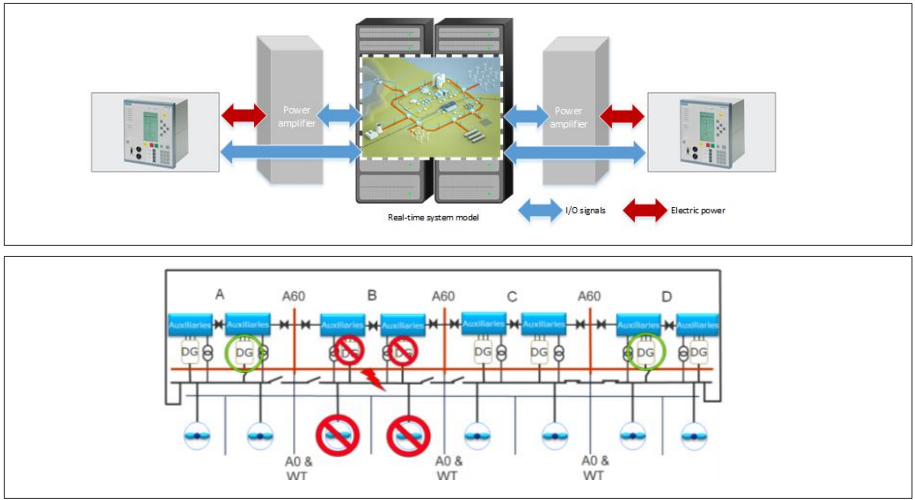
Legend:

- = Failure
- = Unavailable due to failure or considered not to standby start (n-1)
- = Considered to standby start

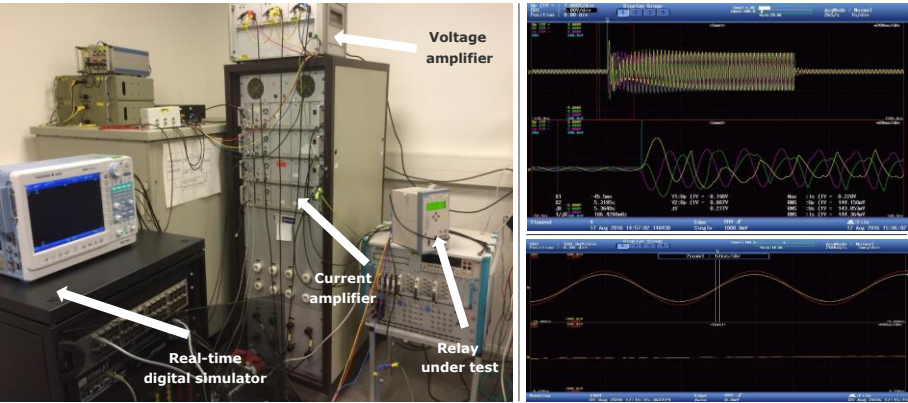


Source: DNVGL-OTG-10 DP Document

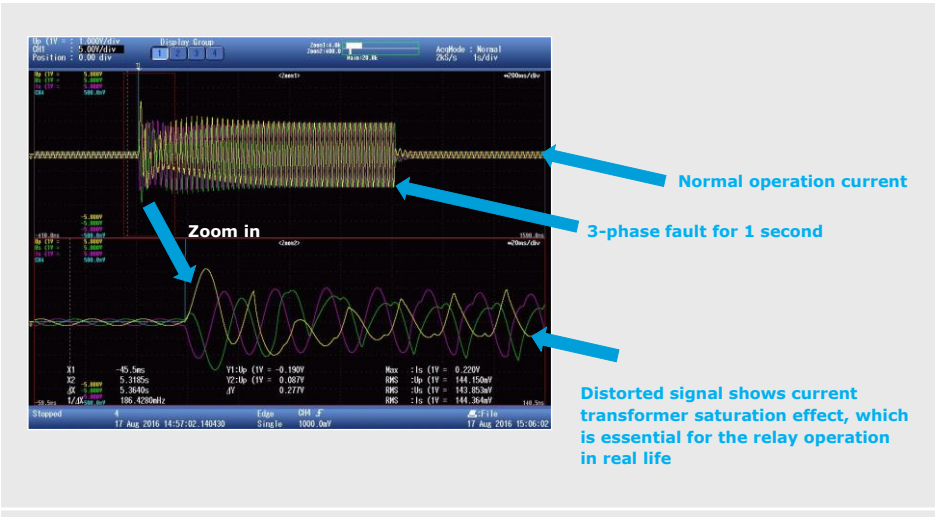
Project concept - overview



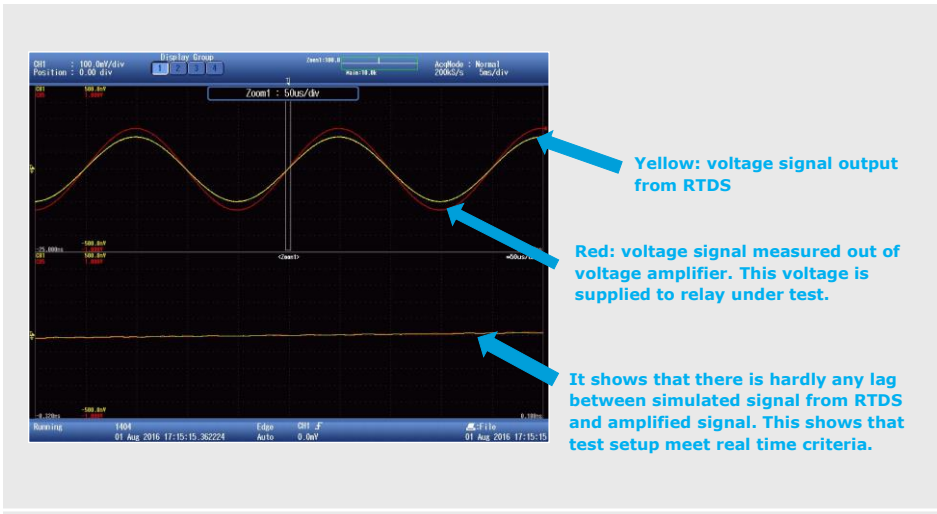
Actual implementation – KEMA Laboratories



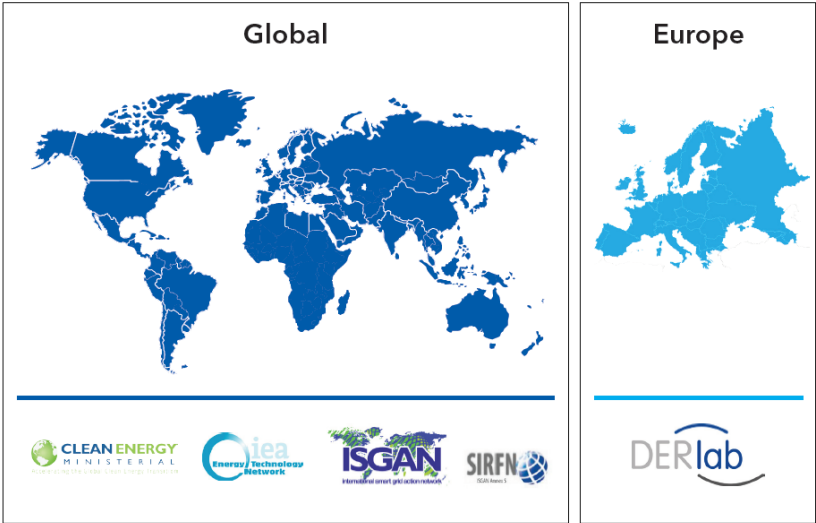
Scope measurement in detail – three phase fault current (1s 3phase fault)



Scope measurement in detail – phase to ground voltage measurement



International cooperation on Power Cybernetics



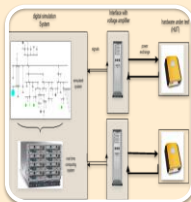



Distributed Energy Resources Laboratories A network of excellence for Smarter Grids



as of March 2016

Overview DERlab capabilities





Full scale testing of DER components

- Lab capabilities up to the MVA range, LV to HV
- Dedicated facilities for all RES technologies
- Compliance testing and validation of all grid relevant functions
- Performance, safety and reliability

Lab and field testing of DER systems

- Testing and validation of power system (ancillary) services from distributed units

Interoperability and communication

- Laboratory platforms able to test the interoperability between DER units
- Testing of communication interfaces according to international standards


Power and Controller Hardware in the Loop (PHIL/CHIL)

- Synthesis of simulation and hardware experiments
- Allows equipment to be validated in a virtual power system

DNV GL position paper on Power Cybernetics is available

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DNV GL 19/09/2016

POSITION PAPER 2016-03
POWER CYBERNETICS
The future of validation

<https://www.dnvgl.com/energy/publications/download/power-cybernetics.html>

Conclusion Power Cybernetics – the future of validation

HIL technique enables flexibility and allows for innovative development, it mitigates the introduction of new and unforeseen error-modes and most importantly prevents proliferation of rogue control software, that over time might jeopardize the entire power system.

However, numerous challenges still need to be solved first and international procedures aligned before testing and certification - based on HIL - will become common place as (component) type certification is today.

Thank you for your attention

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