OPAL-RT TECHNOLOGIES

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HIL-Grid Model on Opal-RT for testing future Grid Control Centers

Eric Glende

Agenda

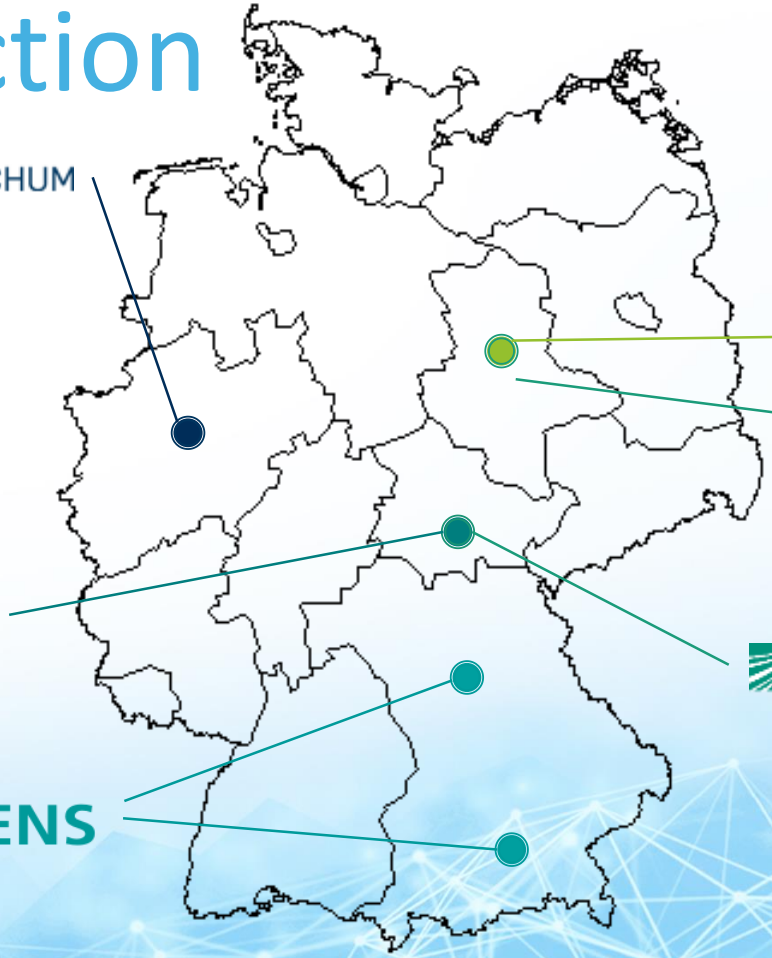
- Introduction
- Dynamic Grid Control Center
- HIL Grid Model
- Communication
- Conclusion

Introduction

RUHR-UNIVERSITÄT BOCHUM

Source: TU Ilmenau

TECHNISCHE UNIVERSITÄT ILMENAU



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High-Performant Assets

- FACTS elements
  - power electronic based DGs
  - HVDC systems

+

- integrative and flexible control algorithms
- high level monitoring
- decentralized control

Source: Siemens

→ Dynamic Grid Control Center (DGCC)

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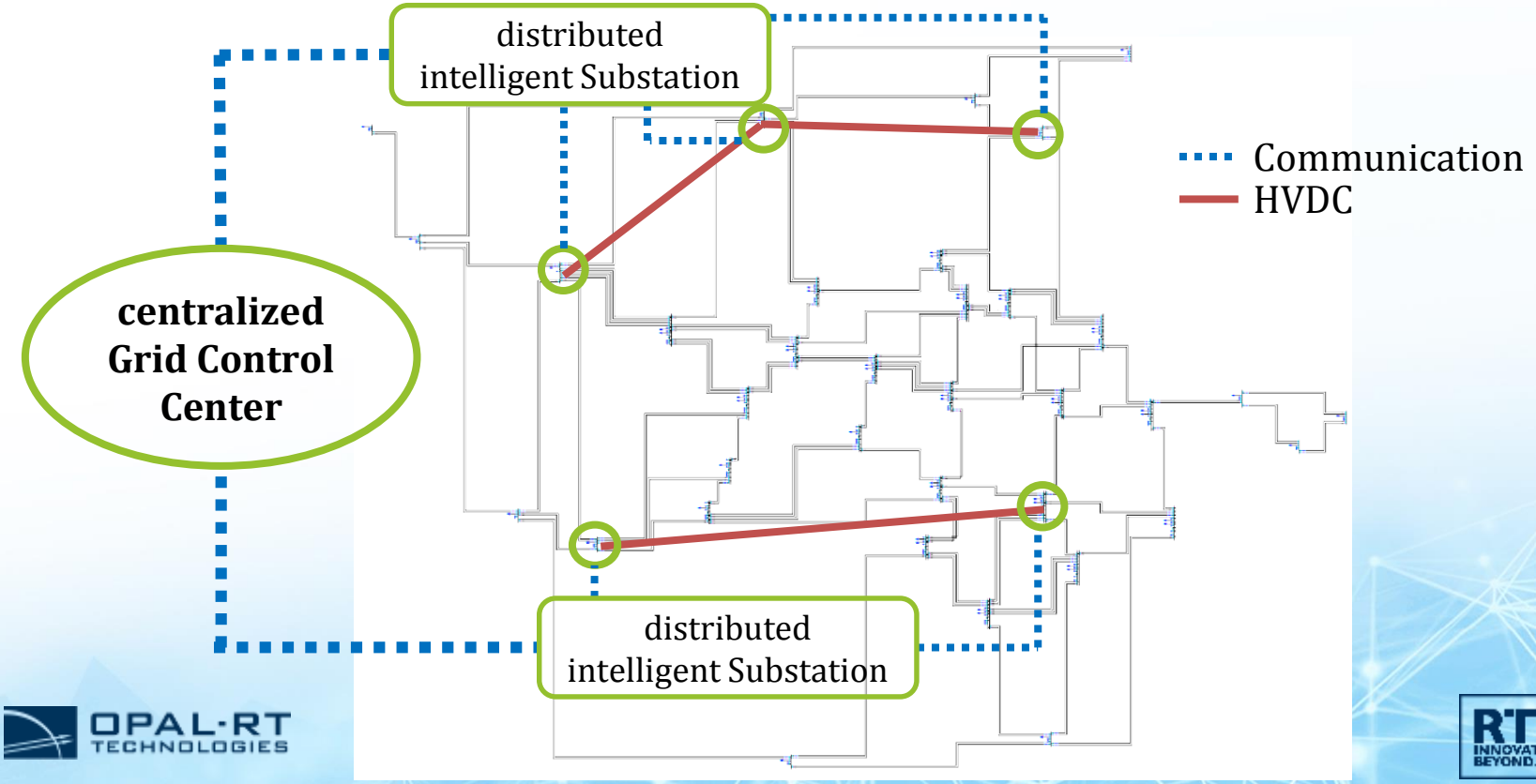
Dynamic Grid Control Center

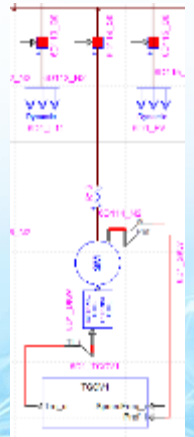


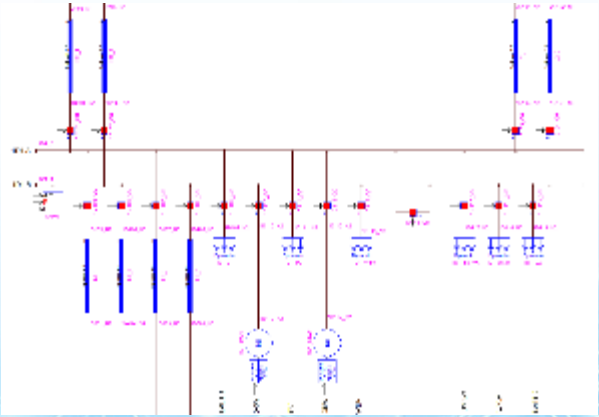
Improvements of DGCC

- dynamic observability
  → identification of dynamic reserves
- permanent corrective and preventive control measures
  → better system stability
- use of precise and synchronous measurements
  → PMU, SynDC, RTU
- consideration of modern communication interfaces
  → IEC 61850, C37.118
- forecast of dynamic behavior for several congestions
- Hierarchy Priority Control Schemes (HPCS)

HIL Grid Model - Hypersim Model

- representation of an synthetic, continental grid with 35 substations
- 700 busses, 80 machines, 200 lines, 810 power devices (loads, DG)
- voltage level 400 kV
- different scenarios will be implemented
  - 8 GW transit from North to South
  - 3 GW offset
  - n-1 contingencies
- use of IEEE controller (TGOV, GAST, EXAC, …)





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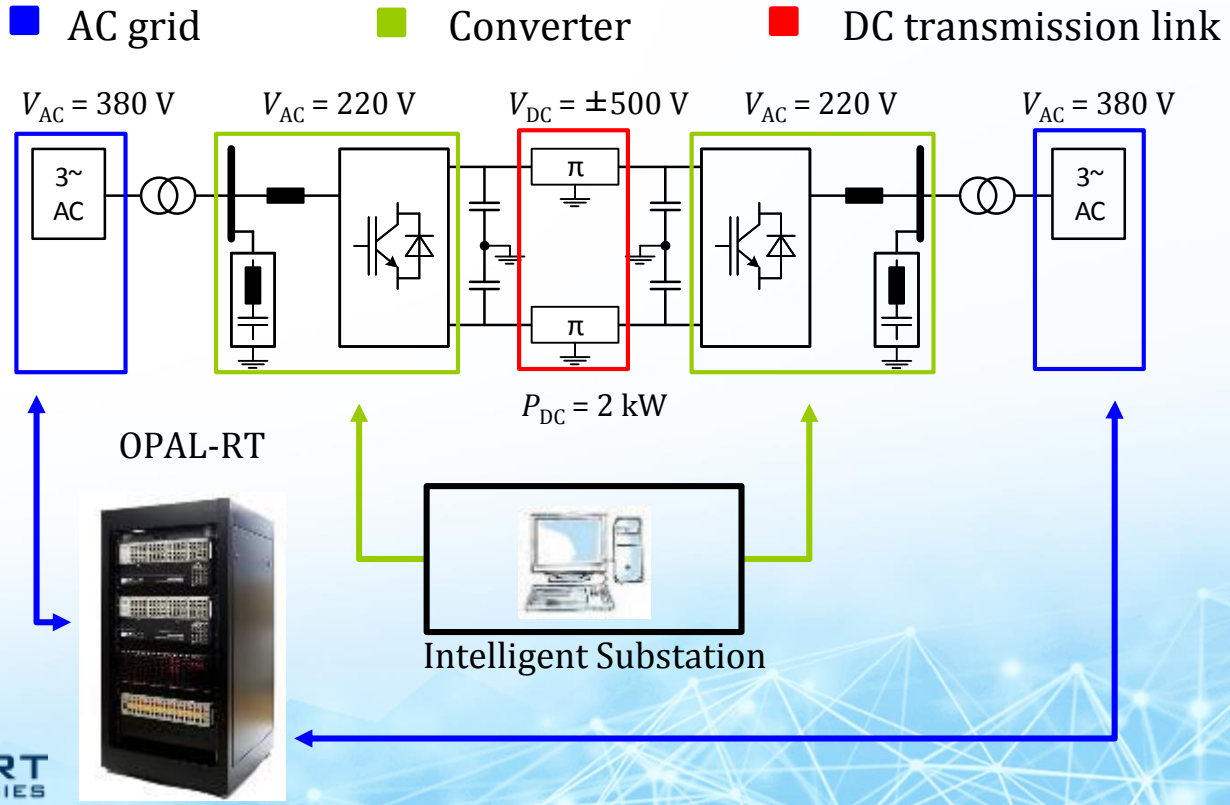
HIL Grid Model - Hardware



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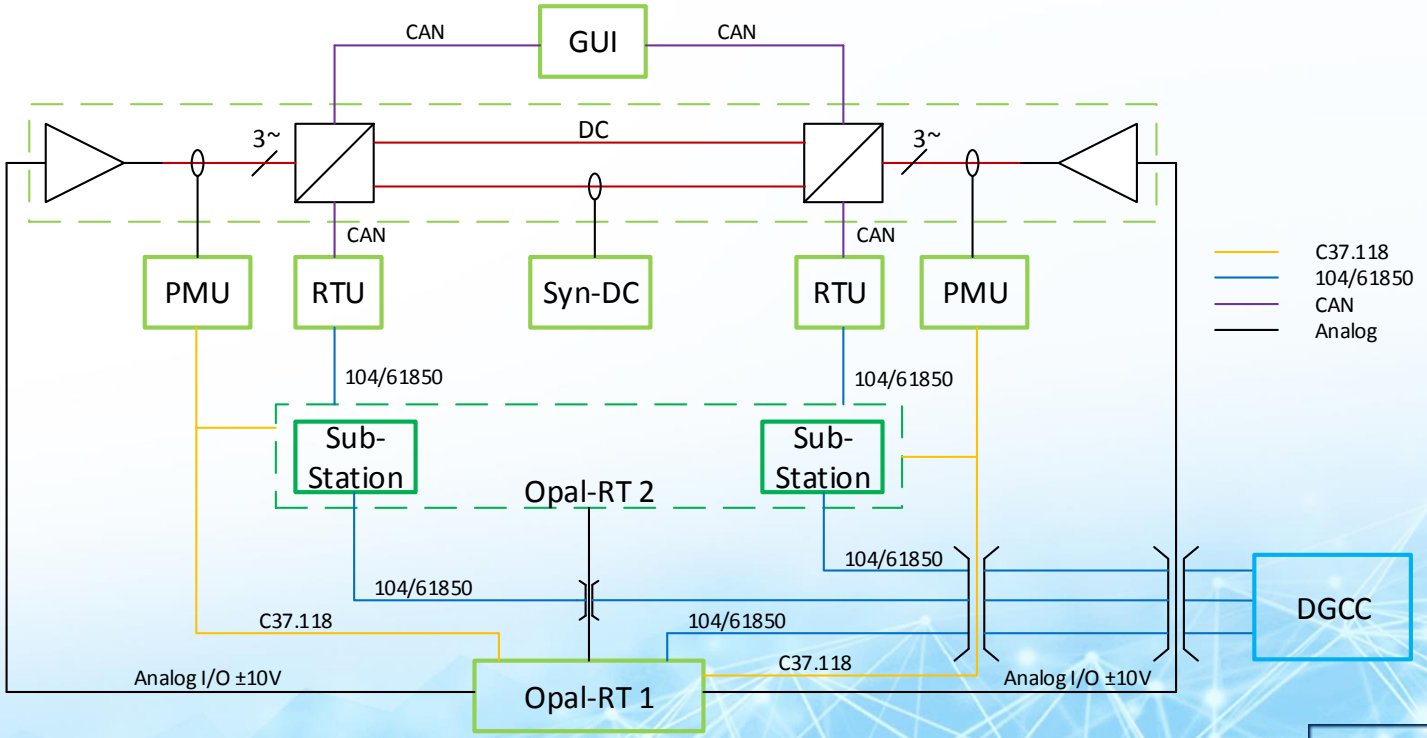
HIL Grid Model - Communication


Source: Siemens



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HIL Grid Model - Scaling

- scaled-down
- voltage U: $1{:}10^3$
- current I: $1{:}10^3$
- apparent power S: $1{:}10^6$

→ affordable, not too big components

→ easy to handle safety aspects

→ simple relation (kV → V)

HIL Grid Model - AC grid

- amplifier with 3 x 2 kVA
- external signals as inputs
- U and I measurements as outputs

$U_{3\sim}$

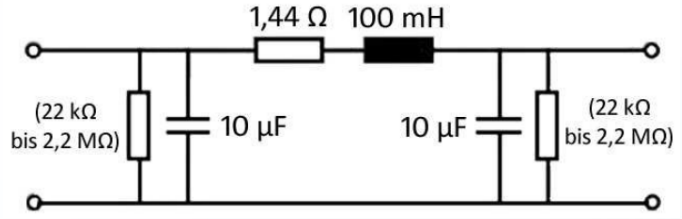
BNC - connectors

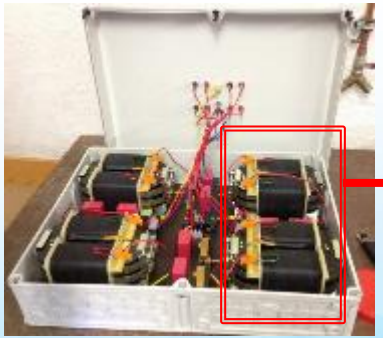
$I_{3\sim}$

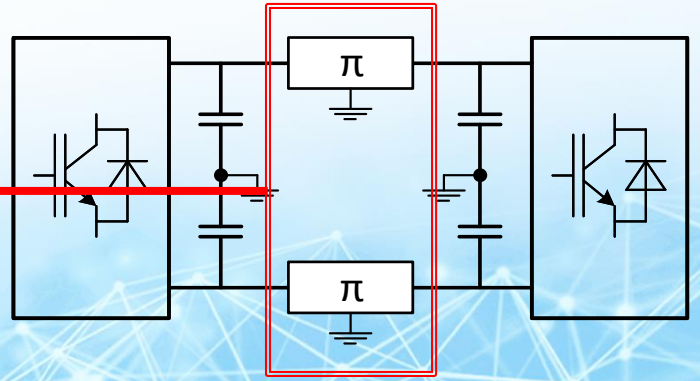
- analog signals from OPAL-RT
- voltage values from the simulated AC grid in real time
- current measurements back to the simulator

HIL Grid Model - Scaling

- pi equivalent circuit
- R, L, C not scaled due to same scaling of U and I
- one element equals 100 km DC cable
- real losses, transients and dynamic behavior







Conclusion

- future grid model with real time software and hardware
- integration of modern HVDC technology
- use of modern measurement technology
- new communication standards in use
- Realization of the optimal and stabilized operation of the system with the use of:
  - measurements
  - ICT
  - control strategies
  - forecasts

outsource the intelligence from the control center to the substation

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THANK YOU

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