New Validation Method for Models for Grid Studies

Hans Dürr, Senvion GmbH
MATLAB Expo
Unterschleißheim, 2017-06-27

SENVION
wind energy solutions

Motivation for this publication

Our goal: create awareness and broaden acceptance in the industry for the approach of validating grid models of wind turbines with reference models

New Validation Method for Grid Models

- Validated grid models – how to get there
- Comparison between different validation methods
- Experiences with the new approach and outlook

Validated Grid Model of Wind Turbines and Wind Farm Components FAQ

SENVION
wind energy solutions

Who asks for validated models?

- Transmission System Operators (TSO)
- Clients of turbine manufacturers
- Certifiers
- Public authorities

When are validated models needed?

- through all phases of turbine life-cycle

What are validated models used for?

- to gain approval of grid access
- to verify turbine and windfarm properties in interaction with the grid
- to dimension windfarm components

What validation guidelines do exist?

- National, e.g. FGW TR4, TR8
- International, e.g. IEC 61400-27
- Project specific

Customer Models for Grid Studies

- Grid operators require **RMS** (root mean square) models of WTGs for grid studies
- Alternatively generic models can be used in some markets (WECC, IEC)
- For instantaneous value analyses **EMT** (electromagnetic transient) models are required

Common Simulation Platforms:

RMS | Generic | EMT

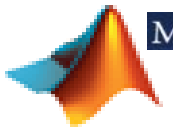
DIgSILENT PowerFactory

SIEMENS PSS®E

SIEMENS PSS®NETOMAC

PSCAD

EMTP-RV The reference for power systems transients



MathWorks

Model Development in MATLAB / Simulink

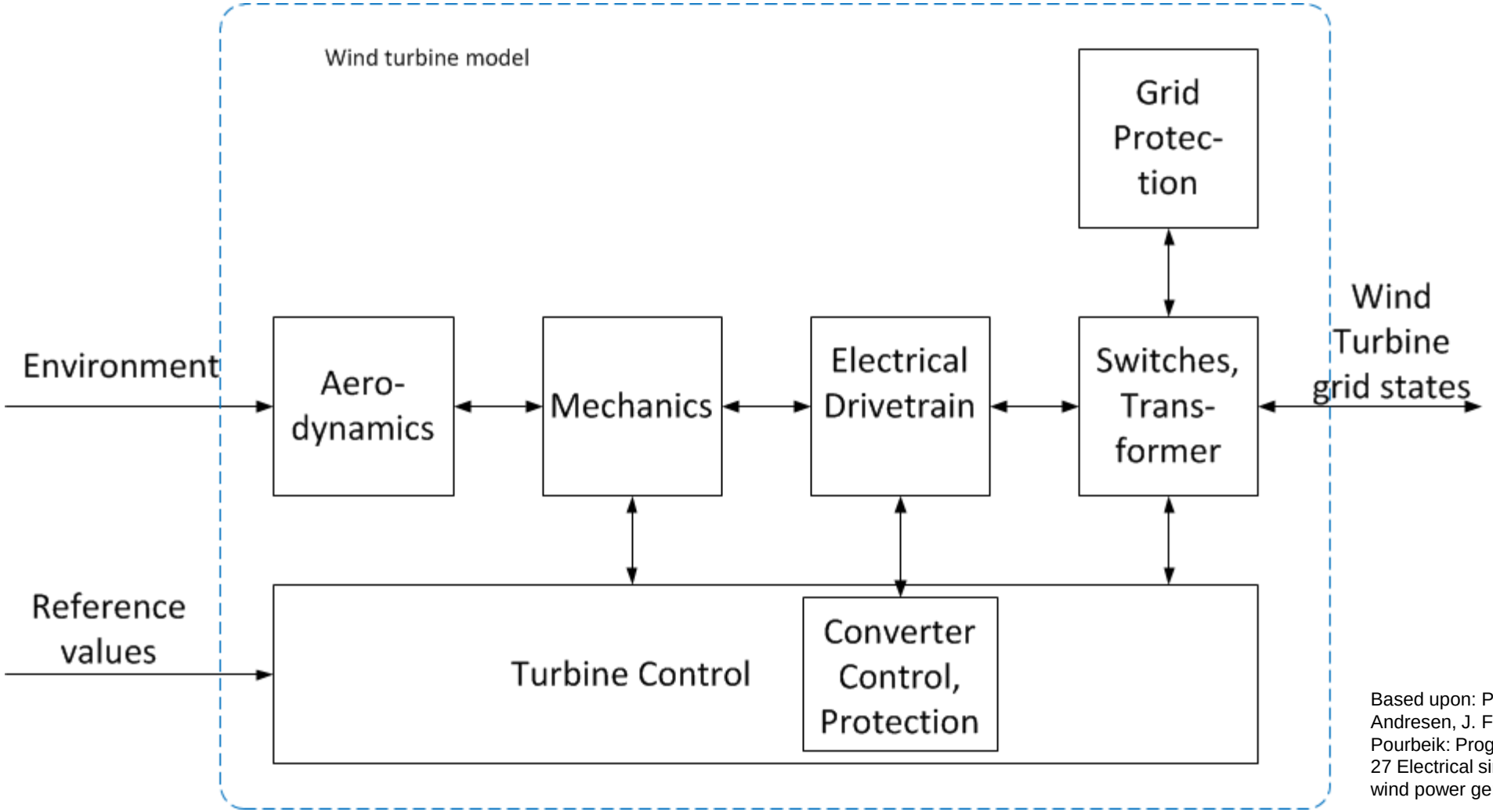
DLL-Generation

Software specific interface

Extended Simulation Environment (ESE)

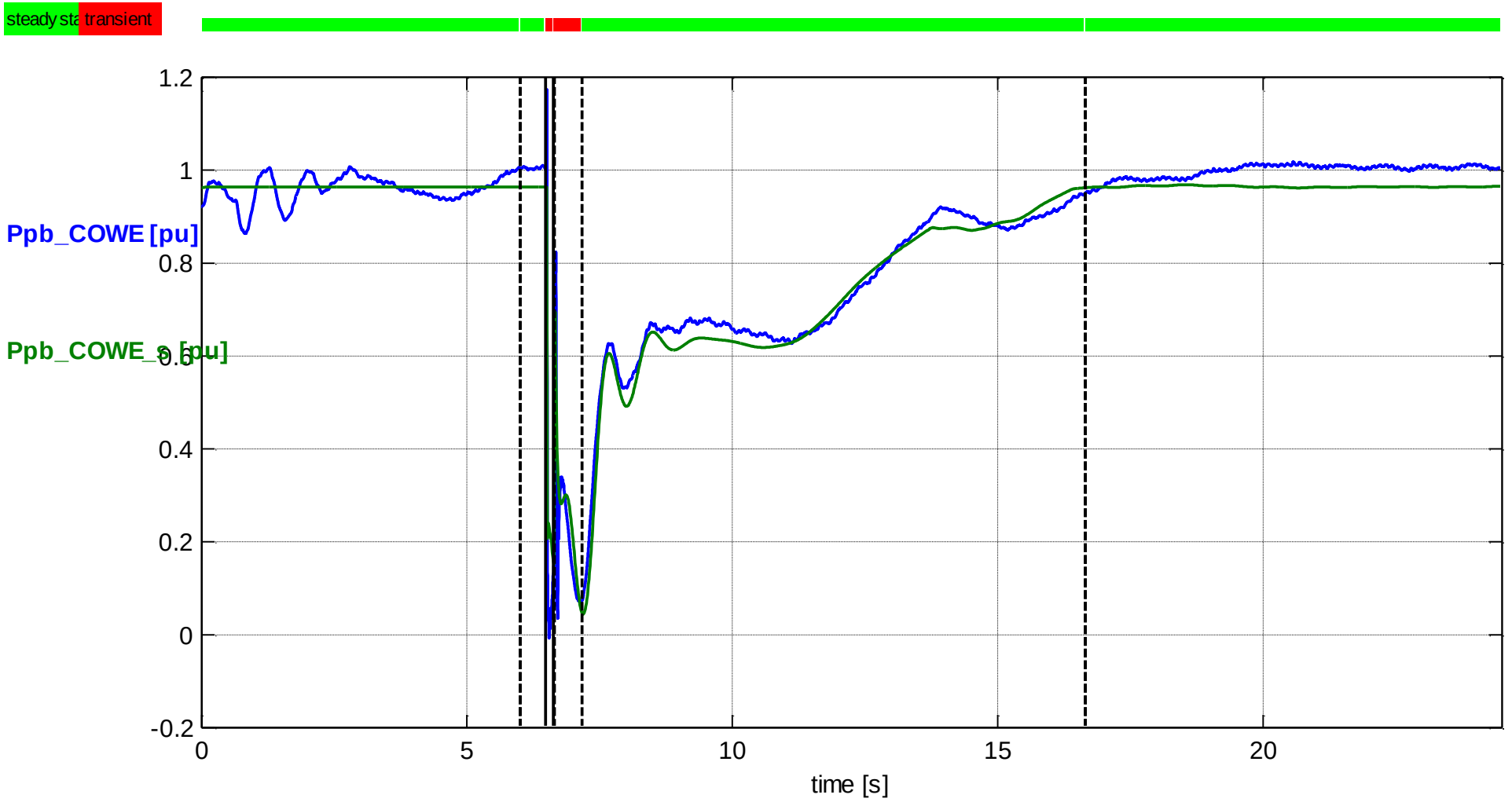
Grid Model Subcomponents

Grid models describe grid relevant parts of windfarm components like turbines



Based upon: P.Sorensen, B. Andresen, J. Fortmann, P. Pourbeik: Progress in IEC 61400-27 Electrical simulation models for wind power generation

Performing Model Validation

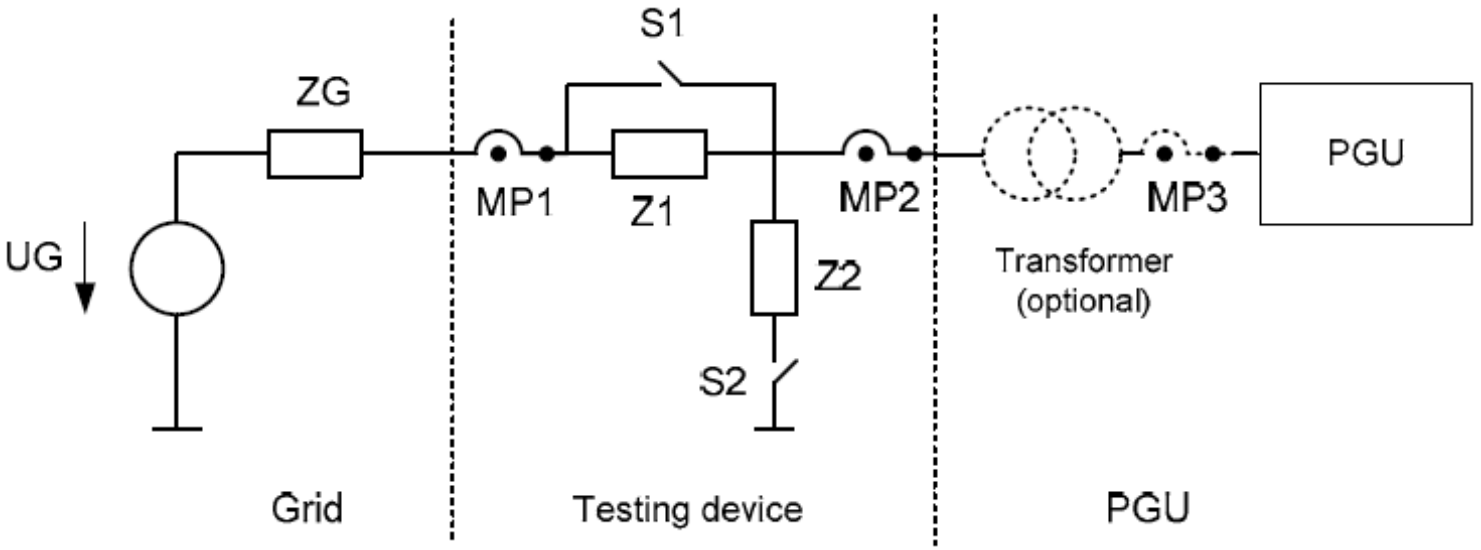


New Validation Method for Grid Models

- Validated grid models – how to get there
- Comparison between different validation methods
- Experiences with the new approach and outlook

Traditional Approach to Gain Reference Data (1)

Fault Ride-Through (FRT) measurement with dedicated testing device (container)



Source: FGW, Technical Guidelines for Power Generating Units. Part 4 Demands on Modeling and Validating Simulation Models of the Electrical Characteristics of Power generation Units and Systems. Revision 5, March 3rd, 2010

Traditional Approach to Gain Reference Data (2)

Advantages of measurements

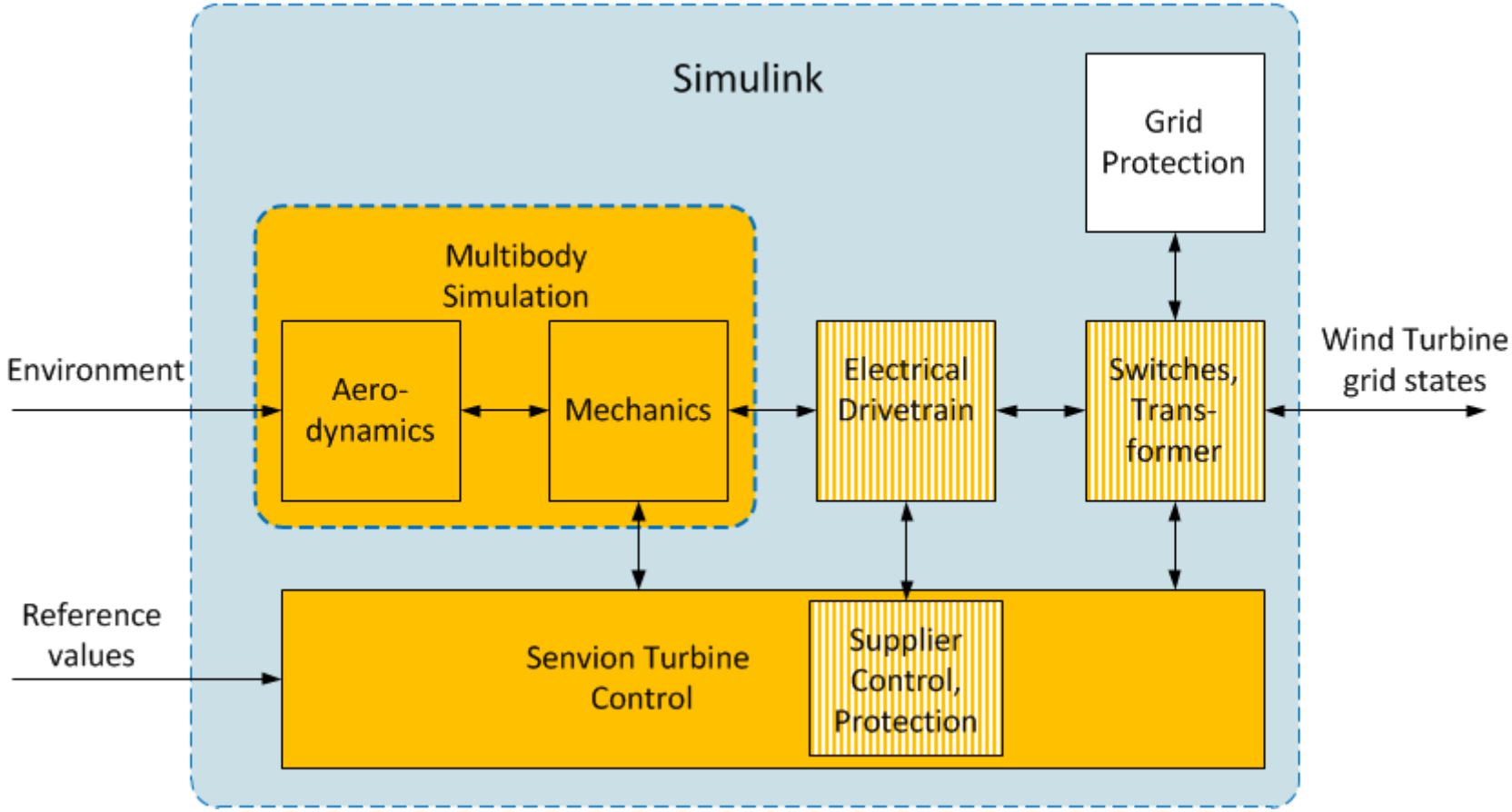
- Close to the truth
- Accepted proof of wind turbine generator (WTG) properties

Disadvantages of measurements

- Huge effort in equipment and adaption of WTG
- Requires significant manpower
- Point of Common Coupling (PCC) needs to have specific properties
- Non-deterministic environment
- Only some relevant tests can artificially be excited: FRT, power quality, P-steps
- Not possible: grid frequency changes

Reference Model as Alternative to Gain Data (1)

- Subsystems represent most detailed modelled components, including original control algorithm
- Calculation of instantaneous values



Reference Model as Alternative to Gain Data (2)

Advantages

- Highly detailed
- Deterministic results
- Easy adjustments of operation conditions
- More analyzed operating points in less time
- Easy exchange of components to support variants
- Debugging in the office
- Fosters model-based design

Disadvantages

- Large computational effort, resulting in long simulation times (comparable to EMT-models)
- High modelling expertise required (model architecture, numerics, co-simulation, variants, tools for automated operation)

New Validation Method for Grid Models

- Validated grid models – how to get there
- Comparison between different validation methods
- Experiences with the new approach and outlook

Experiences and Outlook

So far the approach was used for a major offshore project, where late requirements changes to the turbine made changes to the model necessary.

Another major project is currently in progress.

Outlook

- Continuous validation of the reference model with measurement data
- Further increase of model fidelity

Key Take Aways

Validation of grid models with a reference model

- is feasible and can be accepted in customer projects already
- helps enhancing grid model reliability early in projects

- Our goal: create awareness and broaden acceptance in the industry for the approach of validating grid models of wind turbines with reference models

SENVION
wind energy solutions