DEVELOPMENT OF A DIGITAL TWIN SIMULATION WTG & PPC MODEL IN RSCAD, BASED ON MICROSOFT WINDOWS DLL CODE INTEGRATION BY USING INTERVALZERO

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VESTAS WIND SYSTEMS

USER SPOTLIGHT SERIES 2.0 BY RTDS Technologies

INTRODUCTION

- Increase of renewable energy penetration into the power system, has raised the bar in terms of modeling requirements for wind power plants (WPP)
- The purpose of having SiL/HiL models for an offshore WPP is to de-risk the project by spotting potential compliance issues ahead of time through simulation.
- SiL/HiL models can be a great tool to study the grid code compliance of a WPP, the results obtained from the models will not be reliable unless the models accurately represent the real product.
- The high level of complexity in wind turbine and plant-level controls has the potential to cause grid instability if those controls are not properly represented during the lifetime.

WIND TURBINE MODEL STRUCTURE

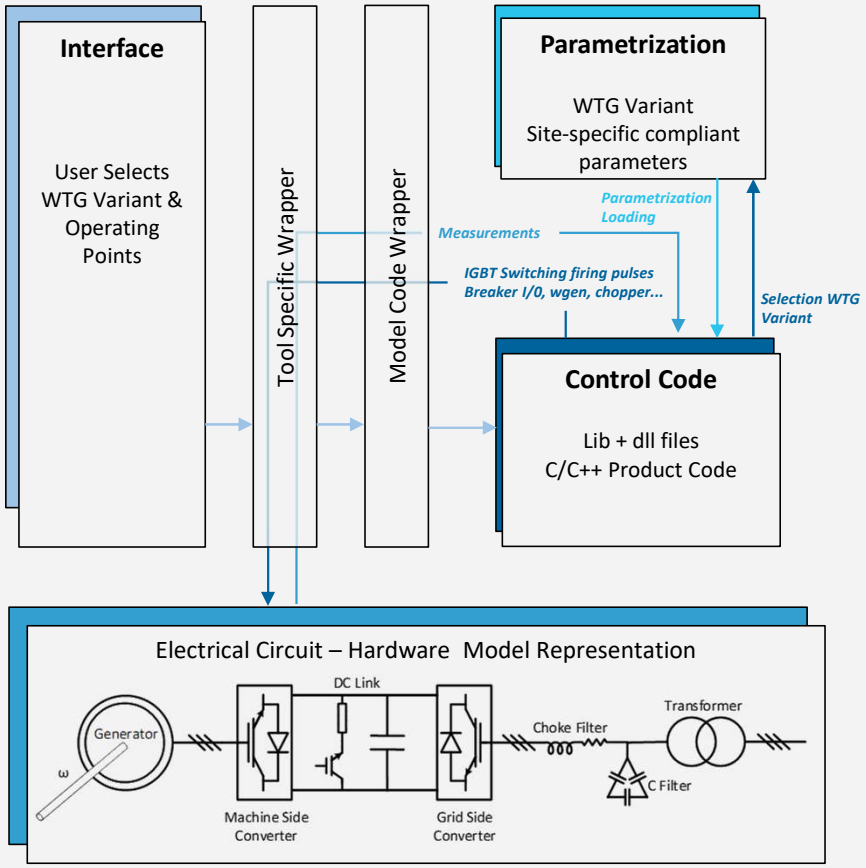
Hardware Circuit
Represents the electric circuit model for a wind turbine. The most common topologies will be Type-3 (DFIG WTG) and Type 4 (FSCS WTG)

Control Code
Source Code from product controller that continuously monitors the state of the input and takes decisions based upon user commands and parametrization

Interface
User Interface to control and configure the model performance. Normally resides in the visual interface of the power system simulation tool

Parametrization
Set of site-specific set of parameters required for grid code compliance in every different market

WIND TURBINE MODEL STRUCTURE



1. Interface

UI is specific to the simulation tool. Users can define in this level the operating points and control strategy of the power plant. Additionally, can configure grid disturbances and dynamic simulations.

2. Control Code

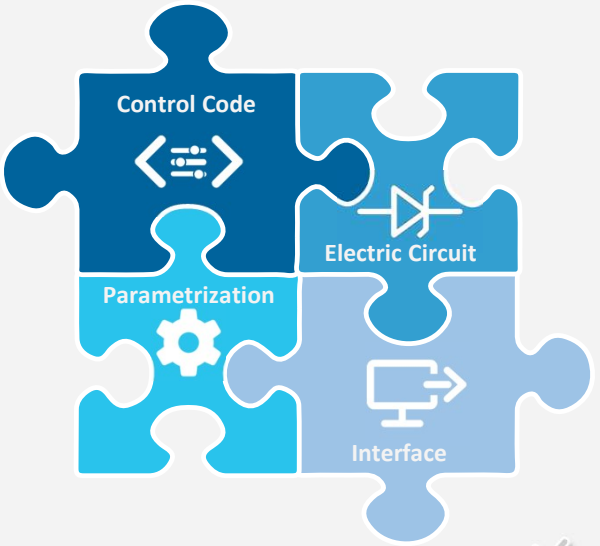
This is delivered in a form of a dll file. Inside this file, all control code is embedded in an encrypted form. User can´t see the control structure, code or functionalities

3. Parametrization

EMT models contain 1000+ parameters for use. However, the vast majority is encrypted and not displayed to the user. Legal/Design teams have approved a set of parameters to be open to users.

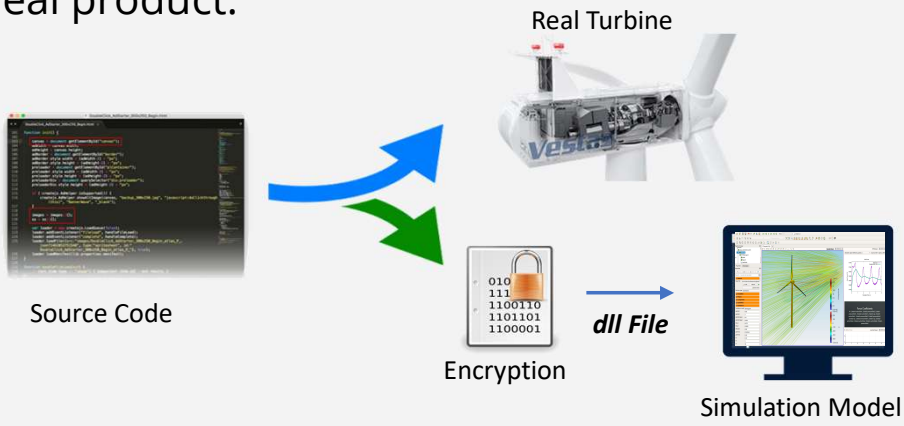
4. Electrical Circuit (only WTG)

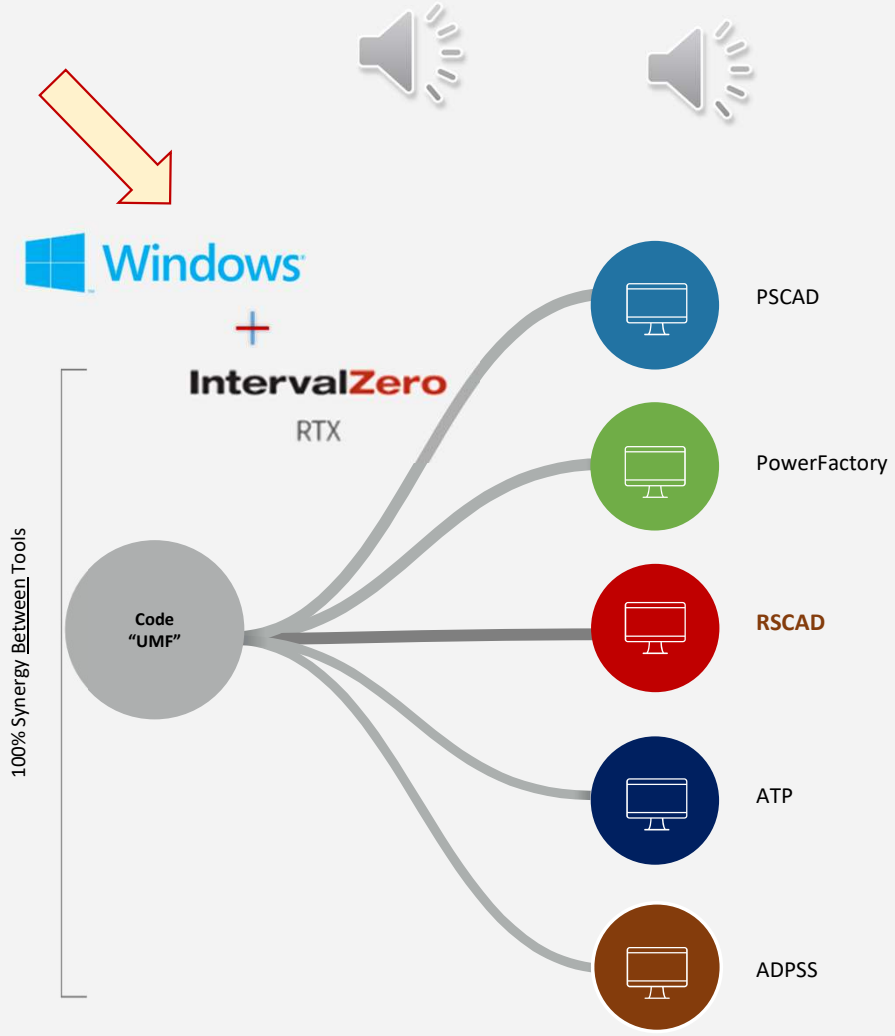
Electrical Circuit hardware is black-boxed in the EMT model. The user has no access to view the electrical connection, circuitry components. (ex. transformer, filters, generator, etc.)



UMF VESTAS MODELS

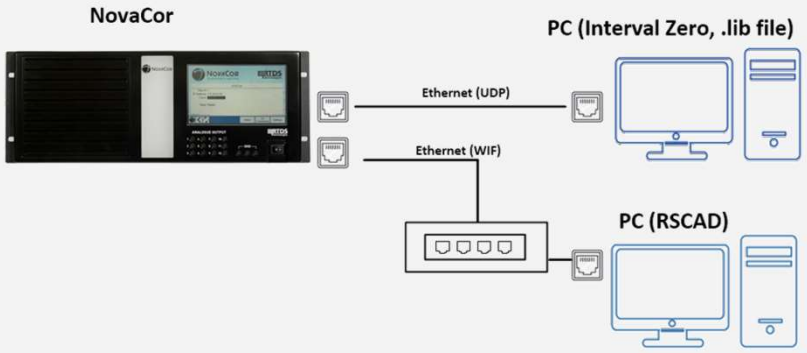
UMF models in EMT (Electromagnetic Transients) software's are built based on real *source code*. *Source code* represents the main control code for wind turbines and/or Power Plant Controller. *Source code* is the actual control code that is installed in the real hardware and operates the real product.

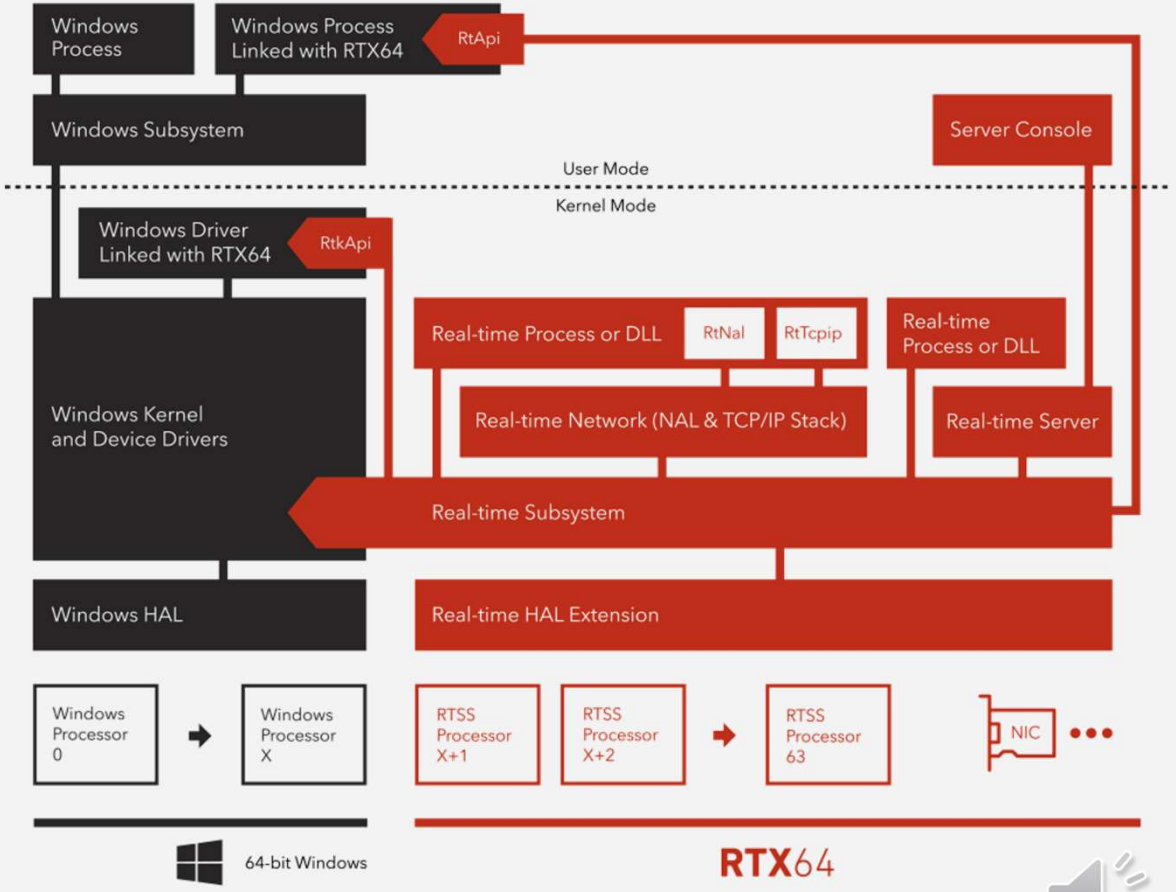




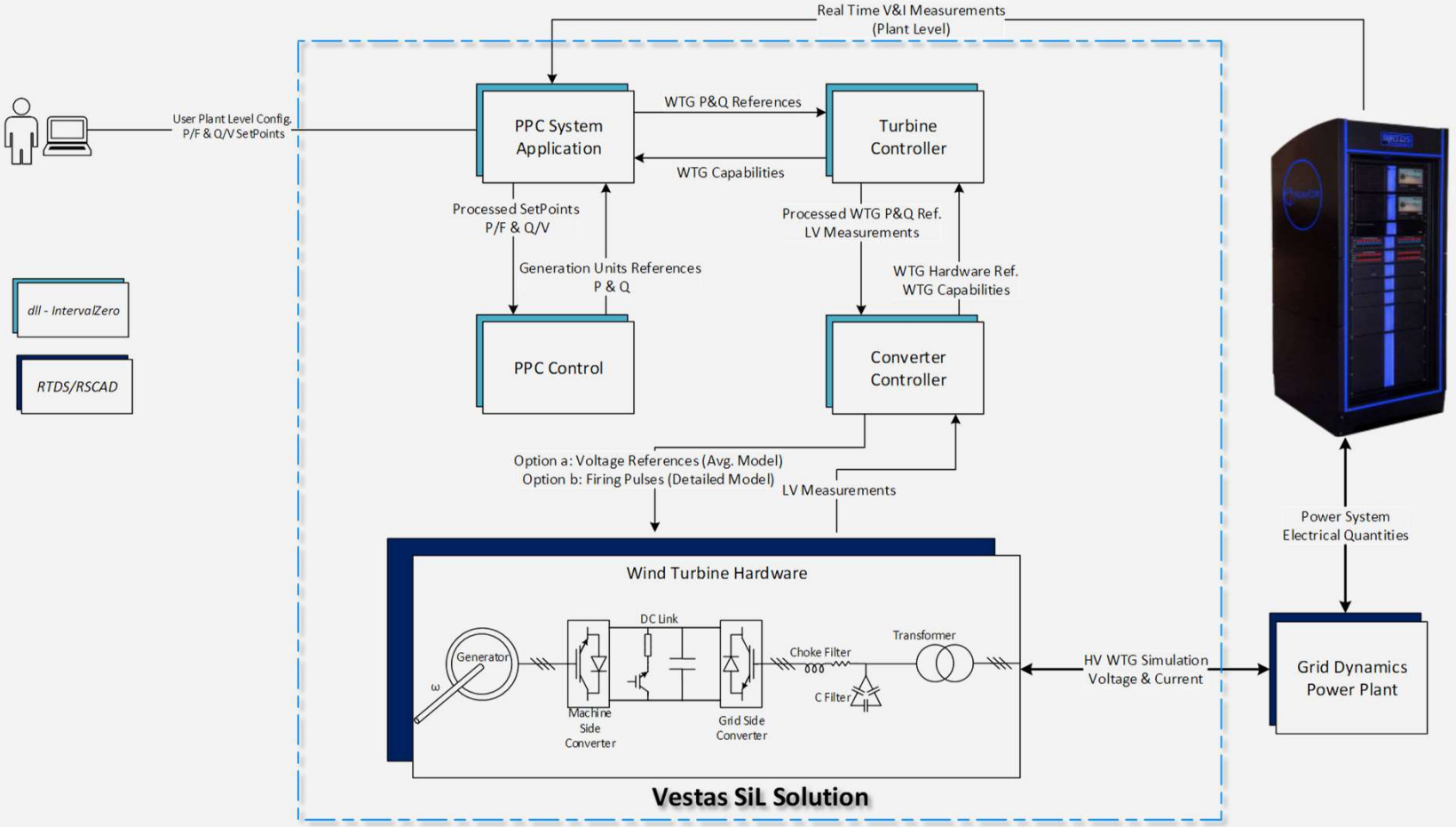
INTERVALZERO OVERVIEW & ARCHITECTURE

IntervalZero is a RTOS Platform that supports determinism or hard real-time on multi-core processors while co-resident with the Windows operating system.

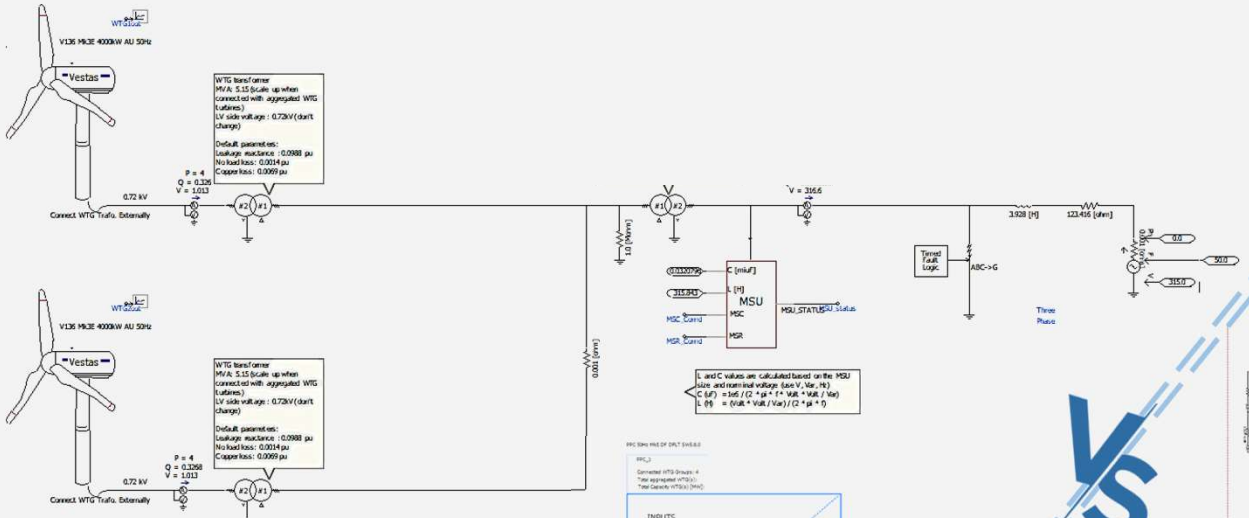




VESTAS WPP SIL SETUP



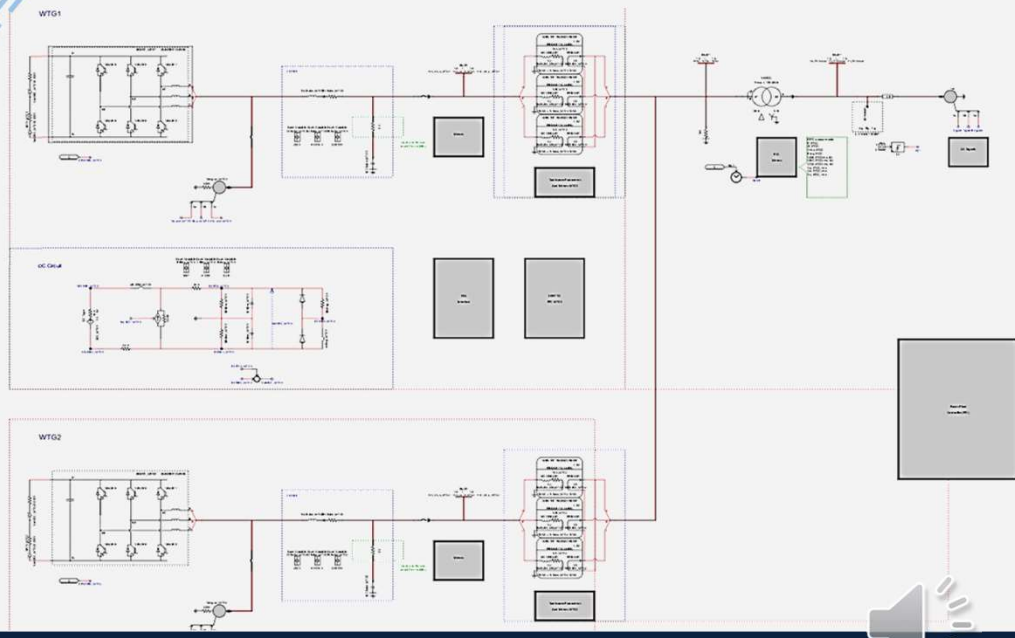
MODEL VALIDATION EMT VS SIL RT



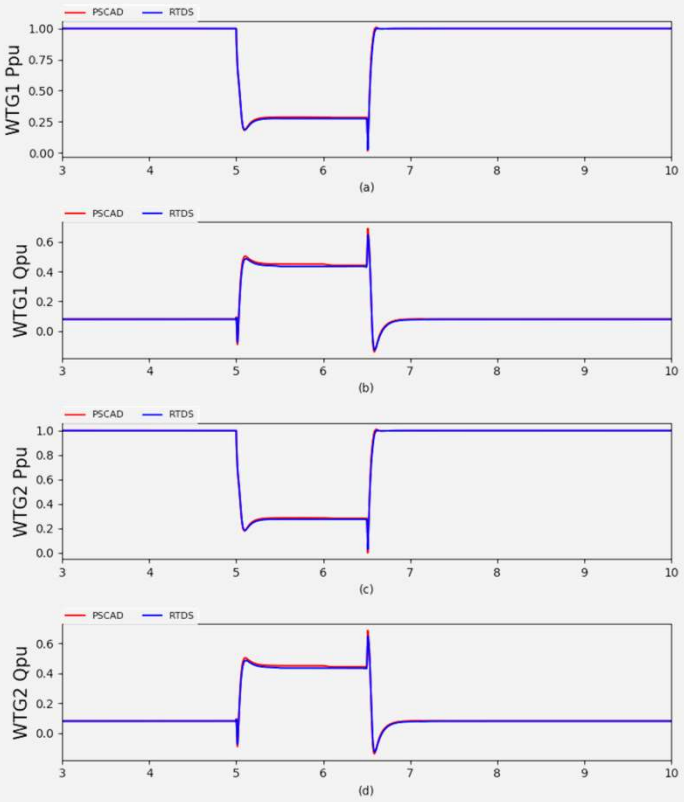
PSCAD

VS

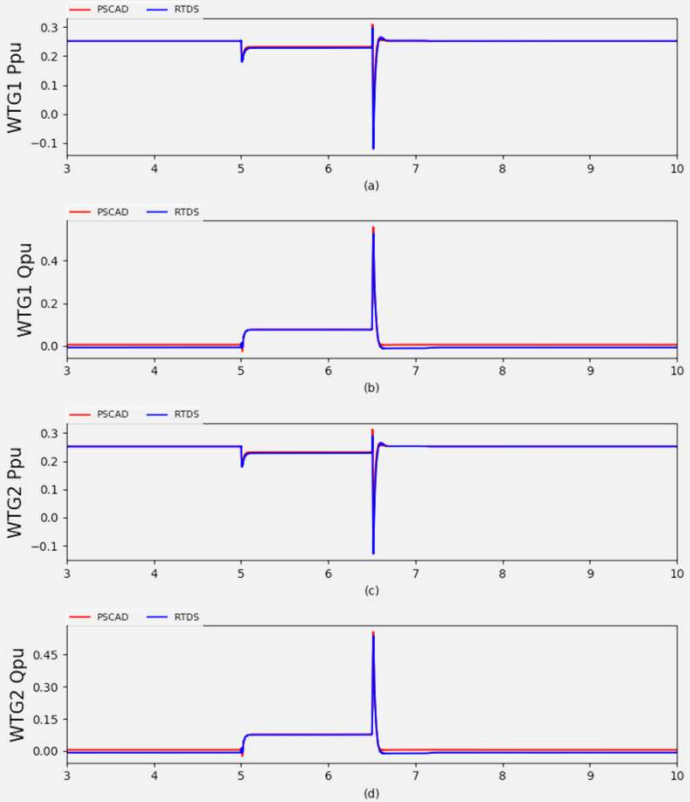
RSCAD®Fx by RTDS Technologies



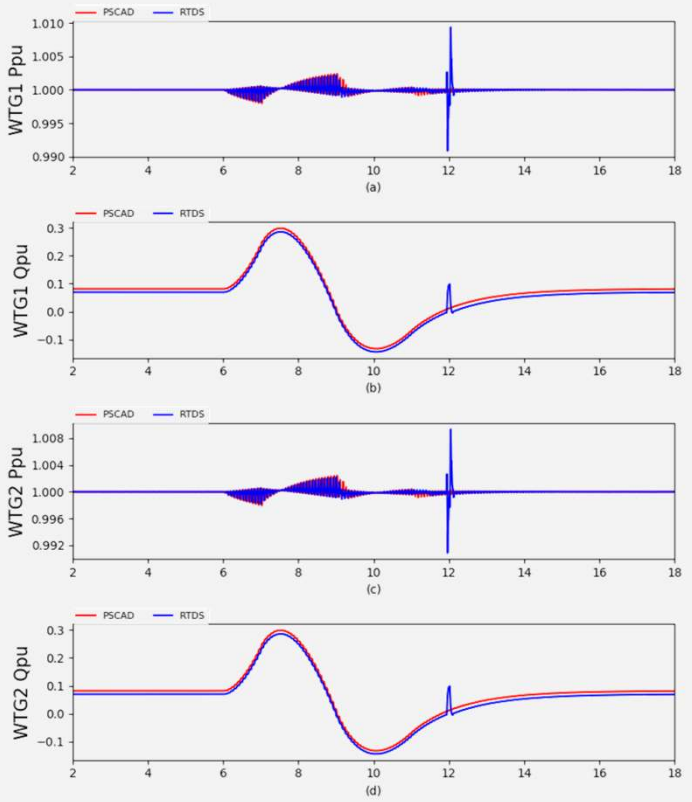
VALIDATION EMT VS SIL RT – RESULTS LV WTG



Case 1: 25% Voltage dip – Full Load

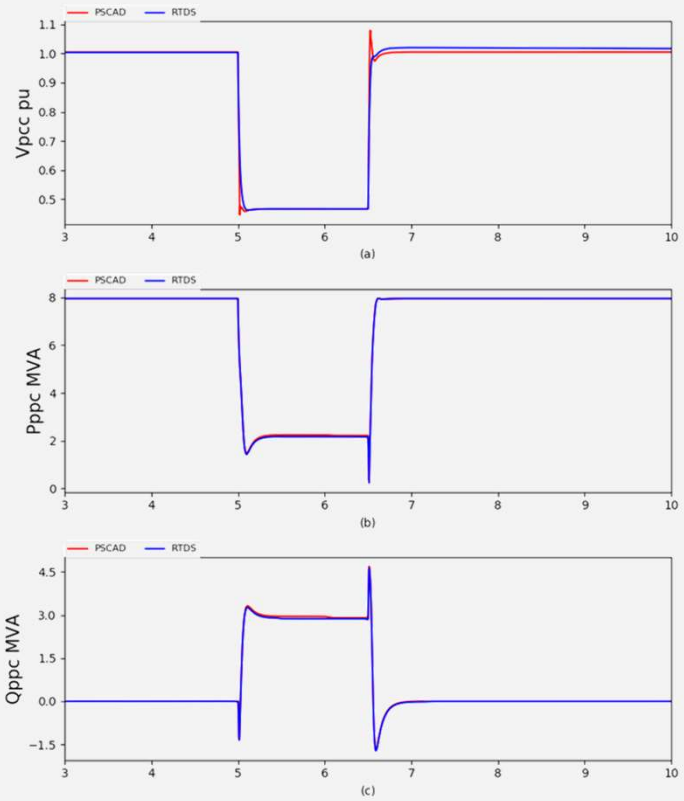


Case 2: 20% Voltage dip – Partial Load



Case 3: Q Ramp up/down

VALIDATION EMT VS SIL RT – RESULTS LV PCC



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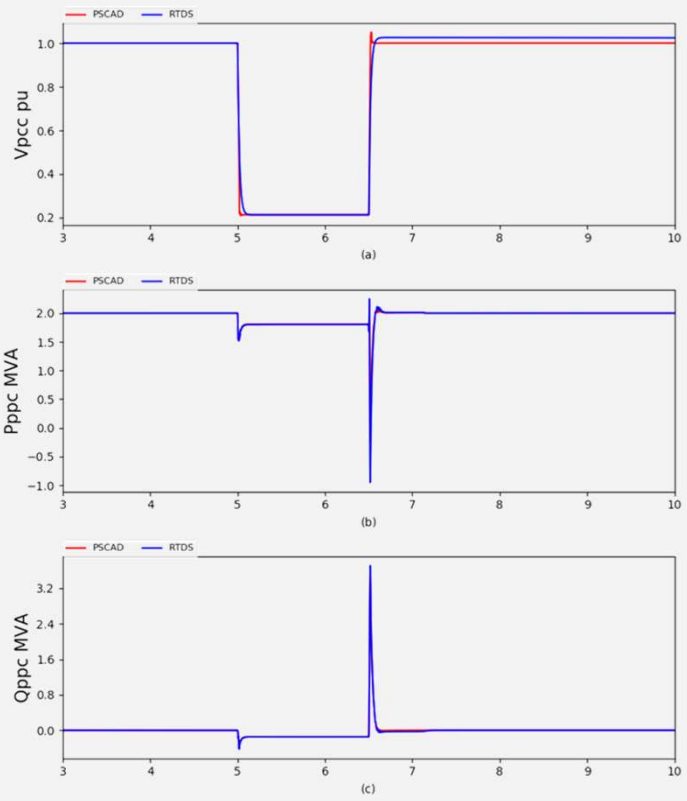

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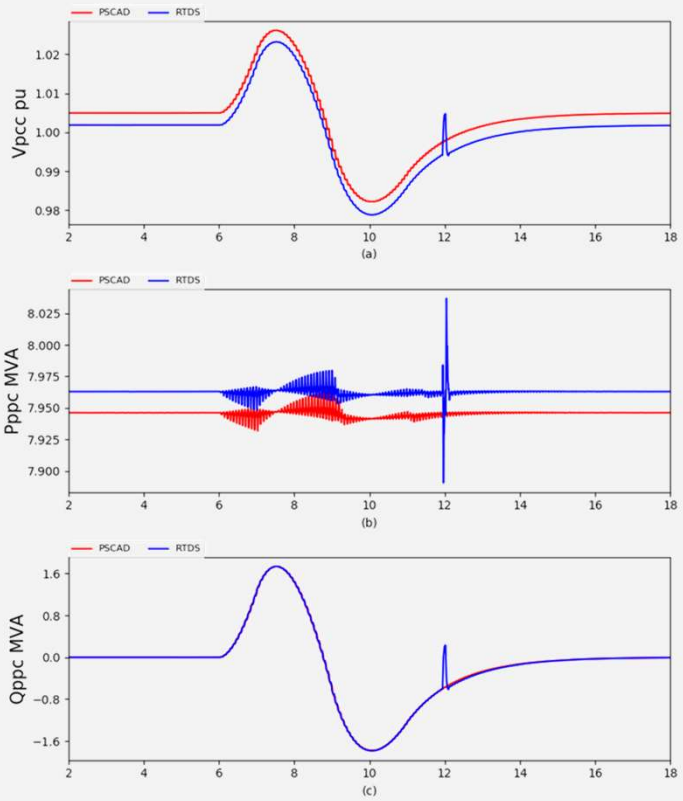

Case 3: Q Ramp up/down

CONCLUSION

- *Model development process in RSCAD can follow a digital twin concept*
- *Model & Product preserves a mirror parametrization and performance*
- *Guaranteed model maintenance and accuracy of the model during the product lifetime*

*"**All models are wrong**; the practical question is **how wrong do they have to be to not be useful**."*

George E. P. Box

How accurate a model must be to perform grid interconnection studies considering the future challenges in a power system with high penetration of inverter-based generation sources?

Source code integrated models

… Digital twin!

Vestas®

Wind. It means the world to us.™

Thank you for your attention

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