2023 Power Conversion, Intelligent Motion Conference (PCIM Asia)

Panoramic co-simulation technology for large-scale offshore wind power

ID: 6338230237

Junyang Zhang
jy_zhang2@qny.chng.com.cn
China Huaneng Clean Energy Research Institute

CHINA HUANENG CLEAN ENERGY RESEARCH INSTITUTE

Abstract

*A new achievement from the research on multi-time scale co-simulation and modeling for large-scale offshore wind power system. The panoramic co-simulation technology takes **multi-dimensional** and **multi-body dynamics** modeling and **multi-time scale** simulation calculation as the basis, integrates **multiple disciplines simulation algorithms**, which combines renewable energy generation and integration.*

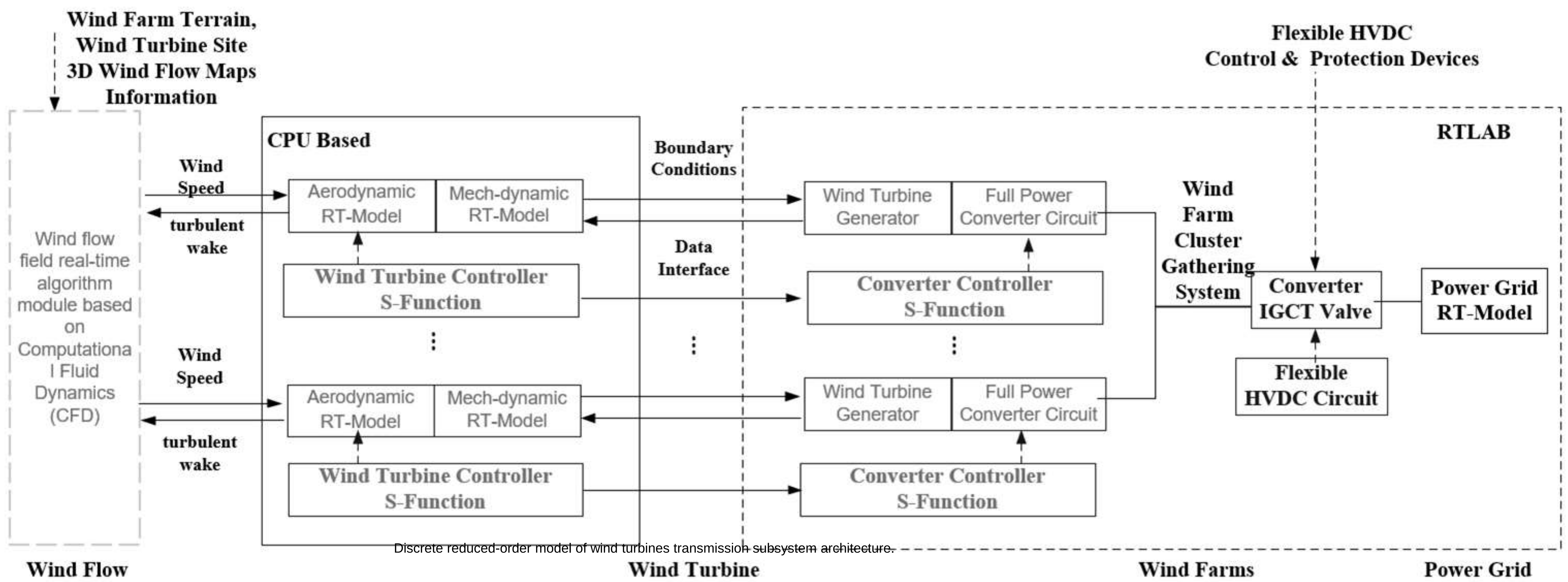


Fig. 1. Wind Resource-Wind Turbine-Wind Farm-Power Grid Panoramic Co-Simulation Model system architecture.

Research Phase

- *Integrated simulation of wind turbine multi-body dynamics*
- *Offline electromagnetic transients*
- *Electromechanical transient modeling*
- *Panoramic co-simulation system modelling*

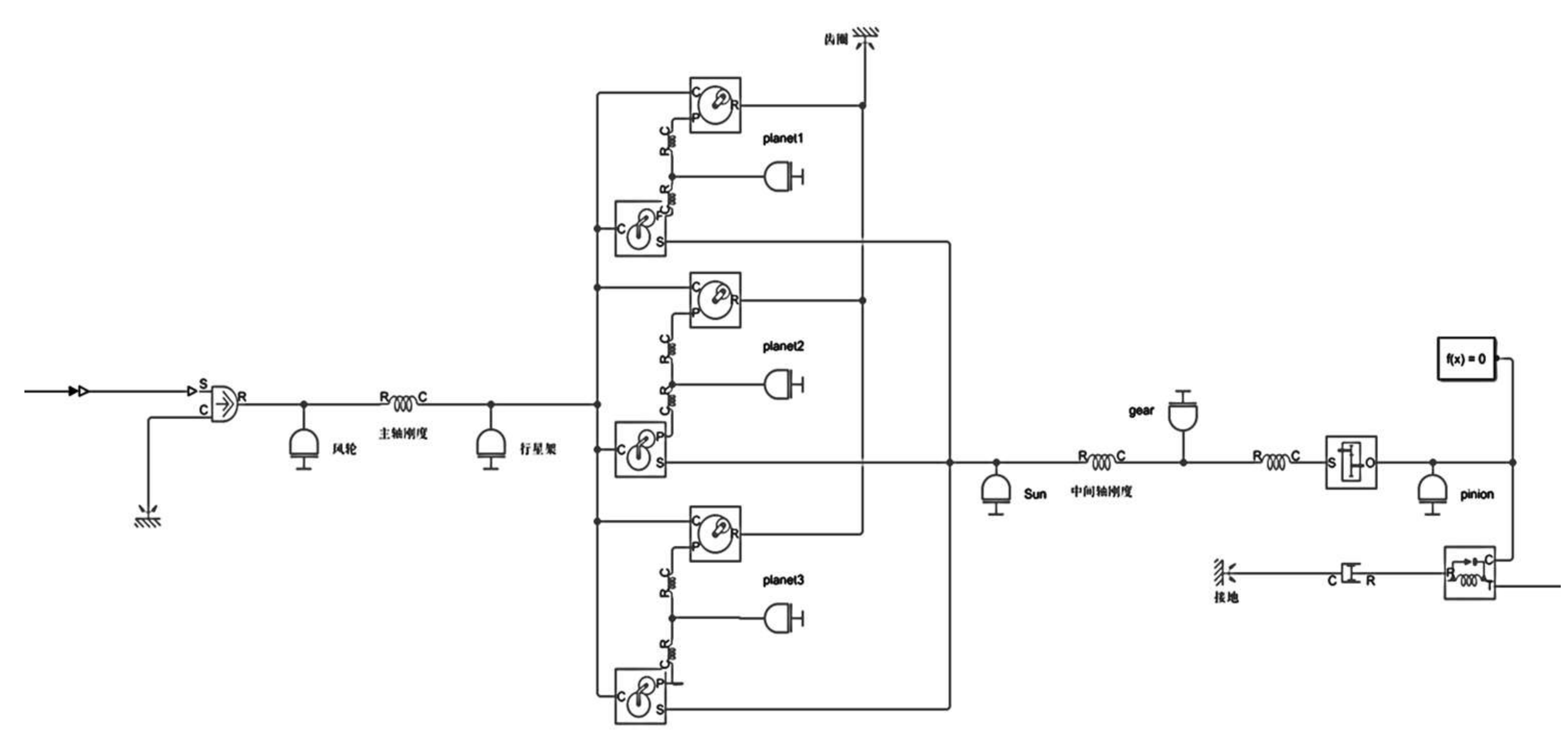


Fig. 2. Discrete reduced-order model of wind turbines transmission subsystem architecture.

System Decomposition

- ◆ ***Wind flow field*** *virtual simulation subsystem*
- ◆ ***Wind energy capture*** *simulation subsystem*
- ◆ *Wind turbine* ***transmission dynamics*** *simulation subsystem*
- ◆ *Wind turbine power* ***generation and integration*** *subsystem*
- ◆ ***Wind farms*** *and power grid simulation subsystem*
- ◆ *External wind turbine* ***controller-in-the-loop*** *subsystem*
- ◆ *Electrical grid* ***integration control*** *subsystem*

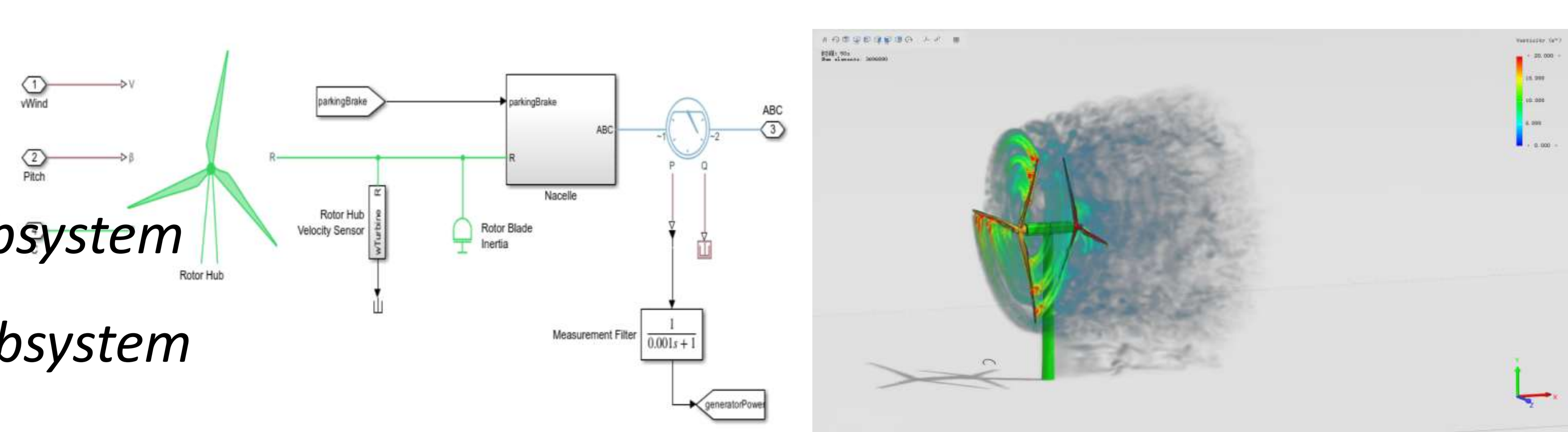
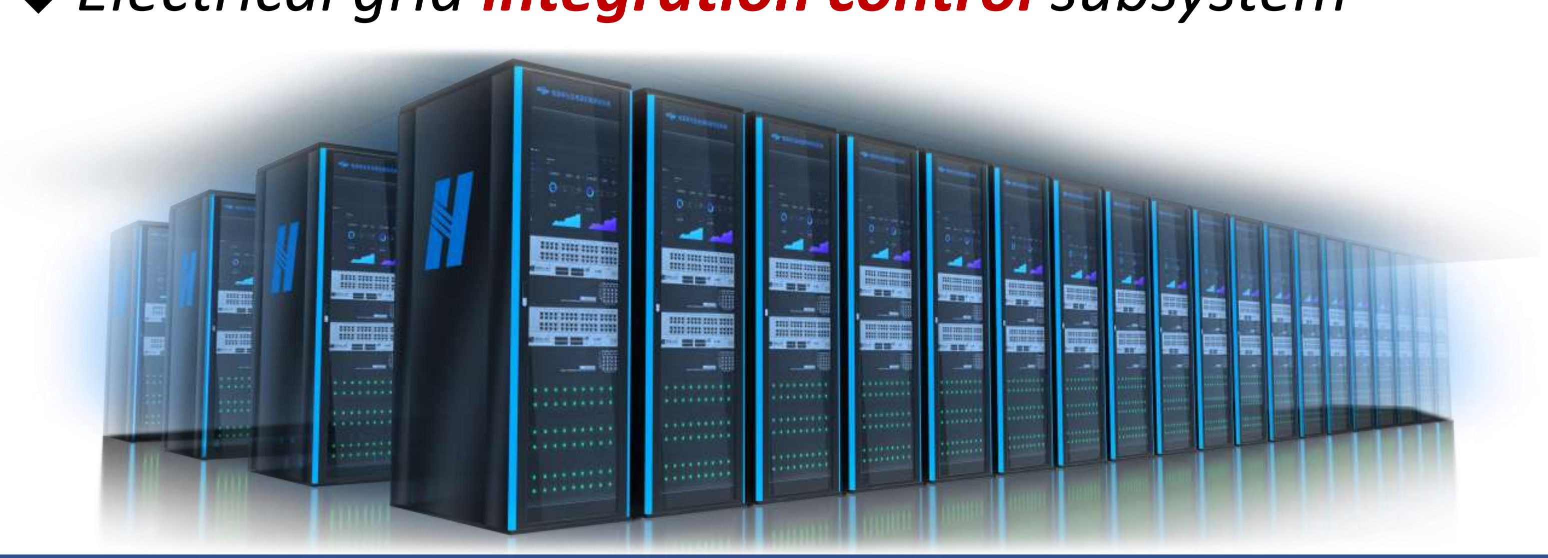


Fig. 3. 3D Wind Flow Maps Simulation Effect Diagram.

Fig. 4. Wind turbine main control, converter controller, wind farm station level controller, HVDC control protection device hardware in the loop.



Panoramic co-simulation technology for large-scale offshore wind power

CHINA HUANENG CLEAN ENERGY RESEARCH INSTITUTE

ID: 6338230237

Abstract

*A new achievement from the research on multi-time scale co-simulation and modeling for large-scale offshore wind power system. The panoramic co-simulation technology takes **multi-dimensional** and **multi-body dynamics** modeling and **multi-time scale** simulation calculation as the basis, integrates **multiple disciplines simulation algorithms**, which combines renewable energy generation and integration.*

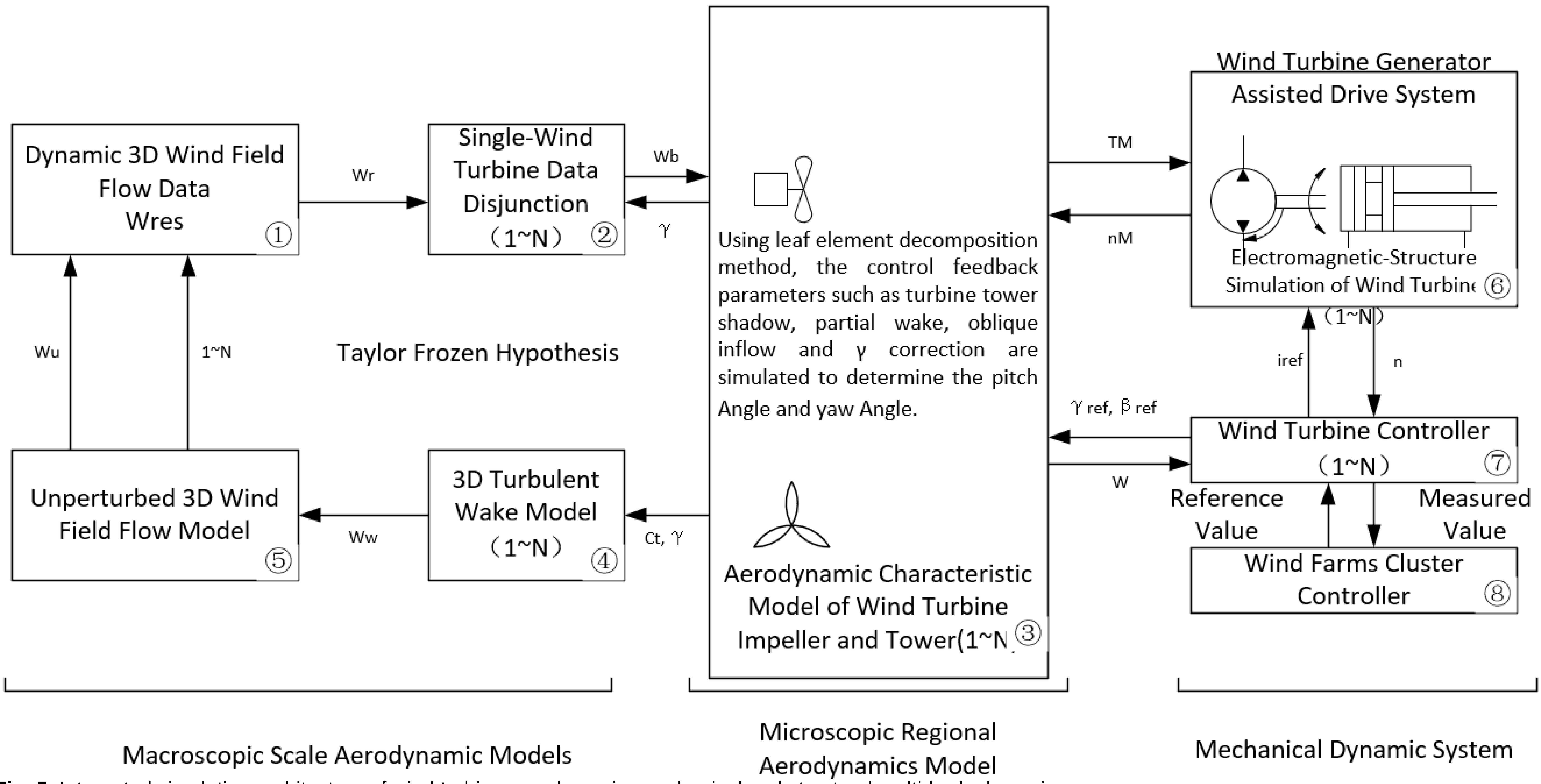


Fig. 5. Integrated simulation architecture of wind turbine aerodynamic, mechanical and structural multi-body dynamics.

System Decomposition

- ◆ ***Wind flow field*** *virtual simulation subsystem①②④⑤*
- ◆ ***Wind energy capture*** *simulation subsystem③*
- ◆ *Wind turbine **transmission dynamics** simulation subsystem⑥*
- ◆ *Wind turbine power **generation and integration** simulation subsystem*
- ◆ ***Wind farms*** *and power grid simulation subsystem*
- ◆ *External wind turbine **controller-in-the-loop** subsystem⑦*
- ◆ *Electrical grid **integration control** subsystem⑧*

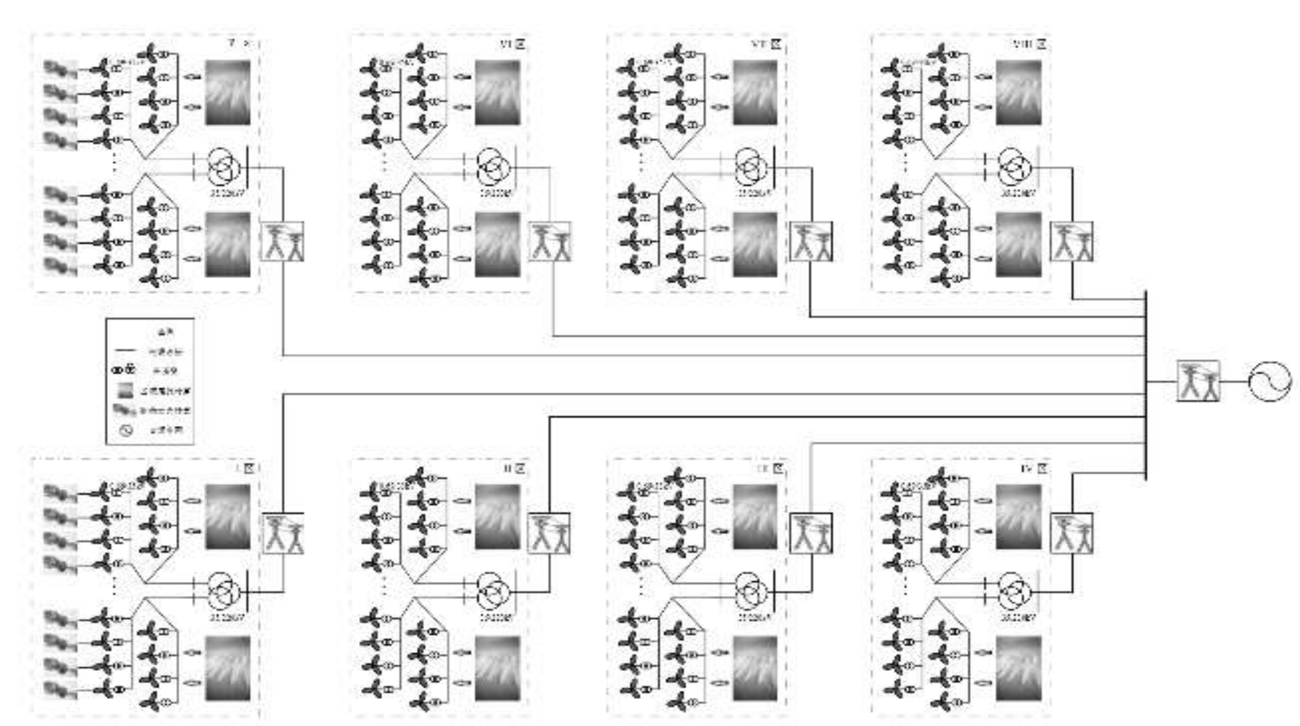


Fig. 6. Large-scale offshore wind farm real-time simulation.

Simulation Hardware Platform Architecture

*Relying on the **RT-LAB platform**, the simulation platform is equipped with hundreds of OP5707 hardware simulation cores to realize large-scale **wind turbine fleet interconnection**, **refined wind farm model configuration** and **real-time data interaction**.*

*Relying on the **HYPERSIM simulation platform**, based on the powerful complex system computing advantages of optical fiber communication interface and CPU, **large-scale wind power grid-connected** and **AC/DC power system** simulation was carried out.*

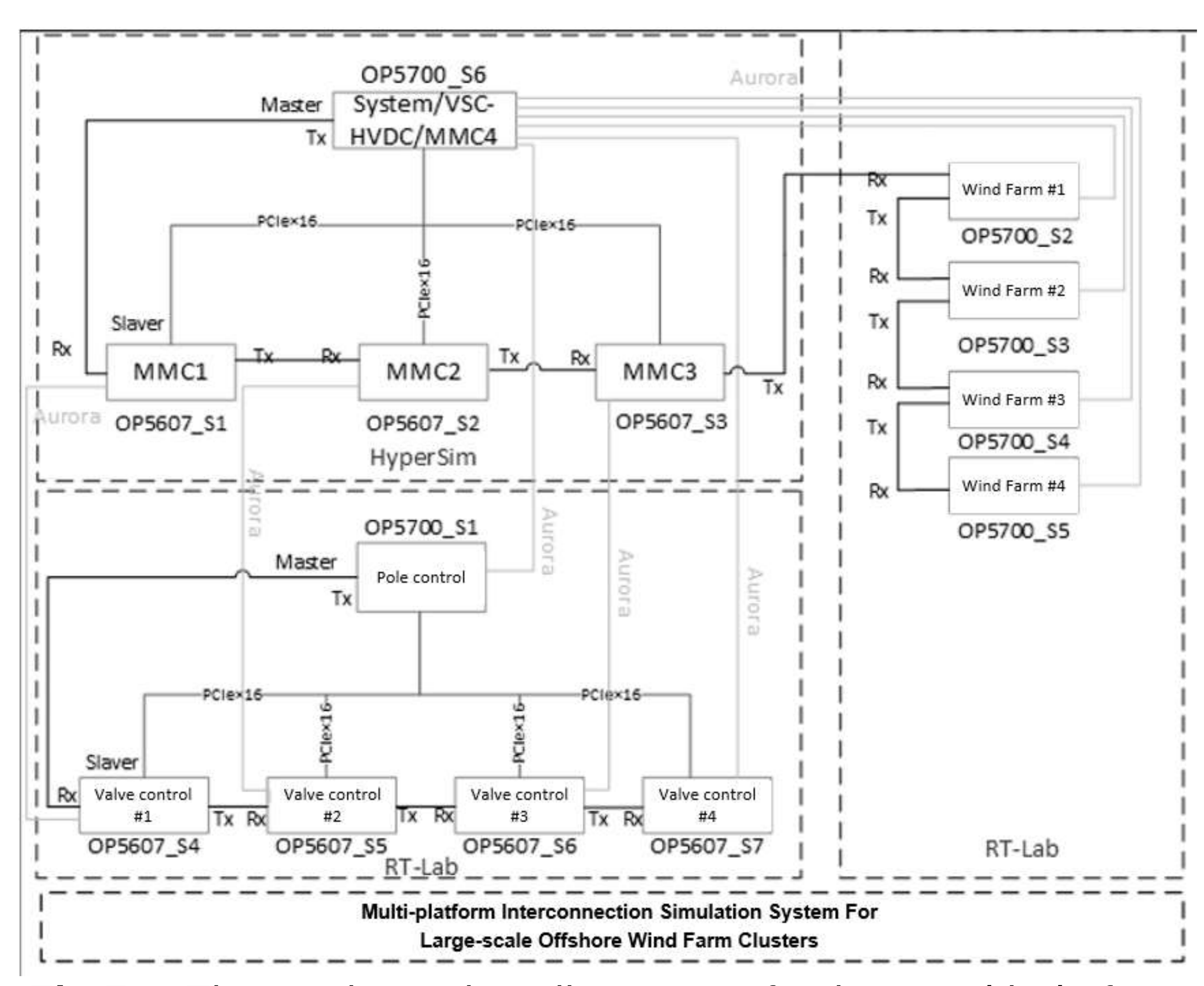


Fig.7. The schematic diagram of the multi-platform interconnection simulation system architecture.

Conclusion

*As the representative application of panoramic co-simulation technology, **Wind Resource-Wind Turbine-Wind Farm-Power Grid panoramic co-simulation technology** has carried out accurately modeling of the whole process of injecting offshore wind power to regional power grid through HVDC, **which has improved the architecture of traditional electromagnetic transient digital simulation of power system.***