Coupled Analysis of High-Fidelity Aeroelastic Wind Turbine and Multi-Body Drivetrain Models

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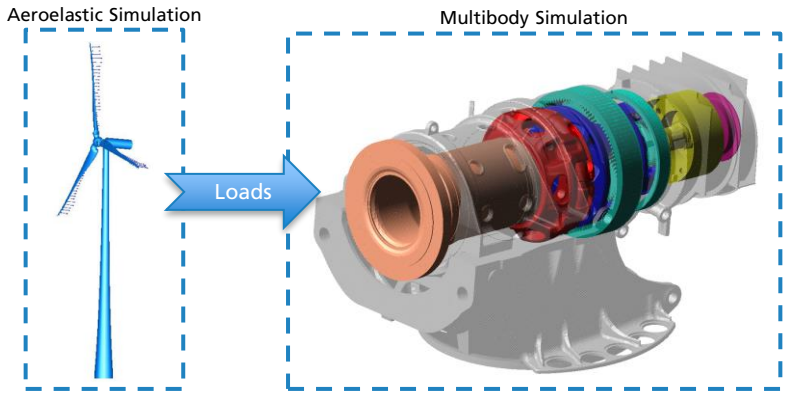
Detailed Wind Turbine Drivetrain Simulation

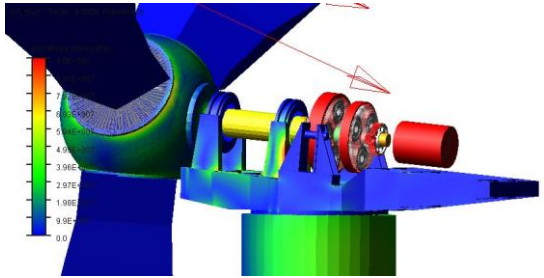
Two approaches for drivetrain simulation are commonly used

Decoupled Approach



- Two Step Approach
- Aeroelastic model provides input loads for MBS model
- MBS model simulates the detailed drivetrain dynamics
- Decoupled simulation. Real system is fully coupled ⚠

Fully Coupled Approach



Source: https://www.mscsoftware.com/

- The MBS software enables the wind load calculation with a specific plug-in or toolbox
- Fully coupled simulation
- Only few MBS software packages offer this feature ⚠
- Entire model restricted to one software package ⚠
- Model execution requires knowledge of both MBS and aeroelastic simulation ⚠

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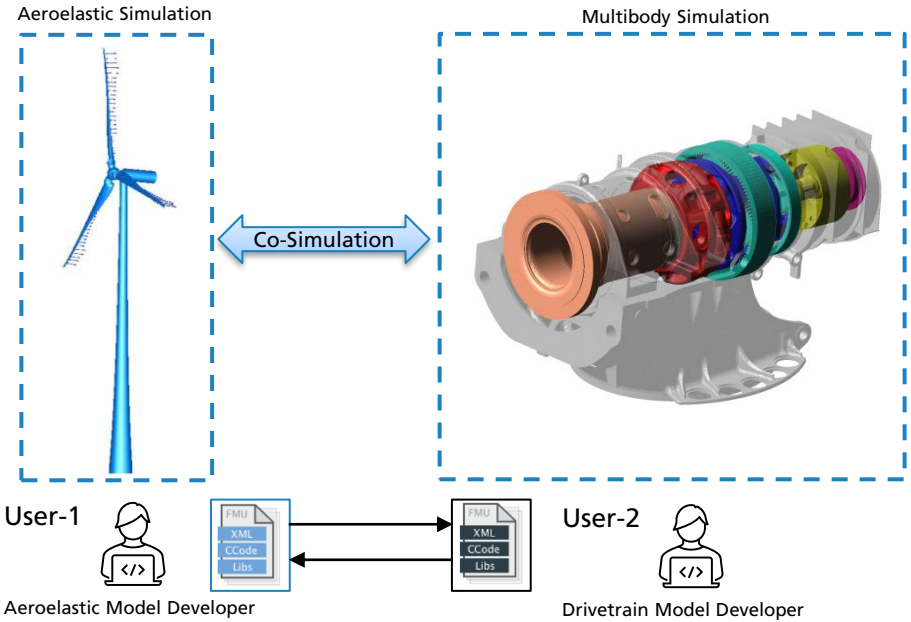
Multi-Software Co-Simulation Approach

Combines the advantages of tailor-made aeroelastic and MBS simulation tools

- Couples an aeroelastic WT simulation software with a drivetrain model in MBS software
- No re-modelling required. The developed models can be directly coupled. No need to model identical systems again in MBS system
- Model developers can remain working with their native software tools
- Model exchange while maintaining confidentiality, e.g., between industry and academia
- Possibility to add more sub-models (heat transfer simulation etc.)



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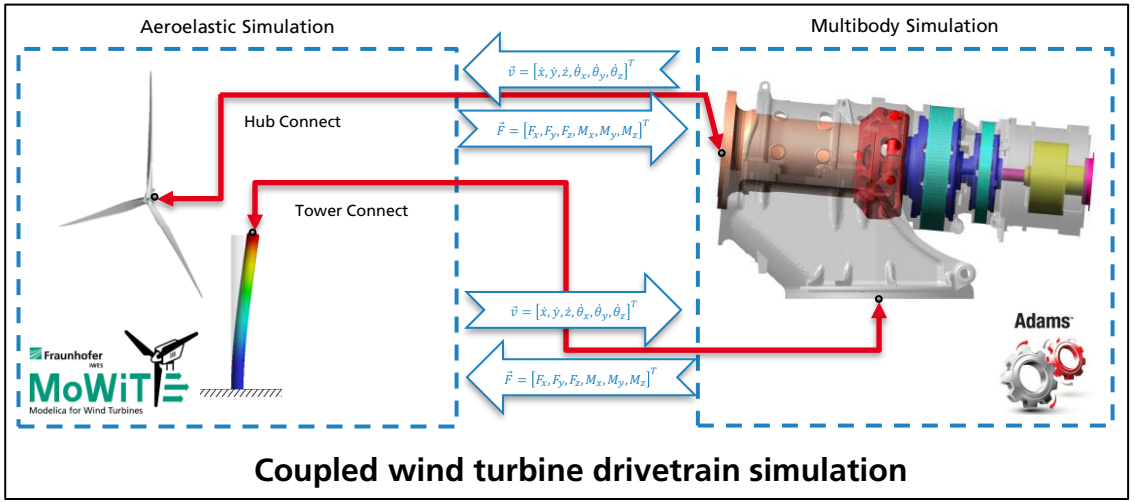
Methodology

Mechanical co-simulation interfaces enable coupled wind turbine drivetrain simulations

- WT model and drivetrain models coupled at hub interface and tower interface
- Interfaces at both connection points transferring forces and velocities
- Coupling performed via model variables that ensure correct power transfer between the two models
- Models communicate during co-simulation through the power variables



Coupled wind turbine drivetrain simulation

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Summary and Outlook

Beneficial approach has been established and will be verified

Summary

- A new method for coupled simulation of wind turbine model and drivetrain model is proposed
- Utilization of native software tools possible
- The models can be shared while keeping all information confidential

Challenges

- Co-Simulation capability of both software required
- Correct definition of the mechanical interface can be challenging
- Options for rotation sequence of angular velocities could cause limitations depending on the software
- Limitations due to solver type and compatibility
- Achieving model stability

Outlook

- Verification using the AD8-180 WT models