

AEOLUS

Modeling and control of large-scale offshore wind farms

Introduction

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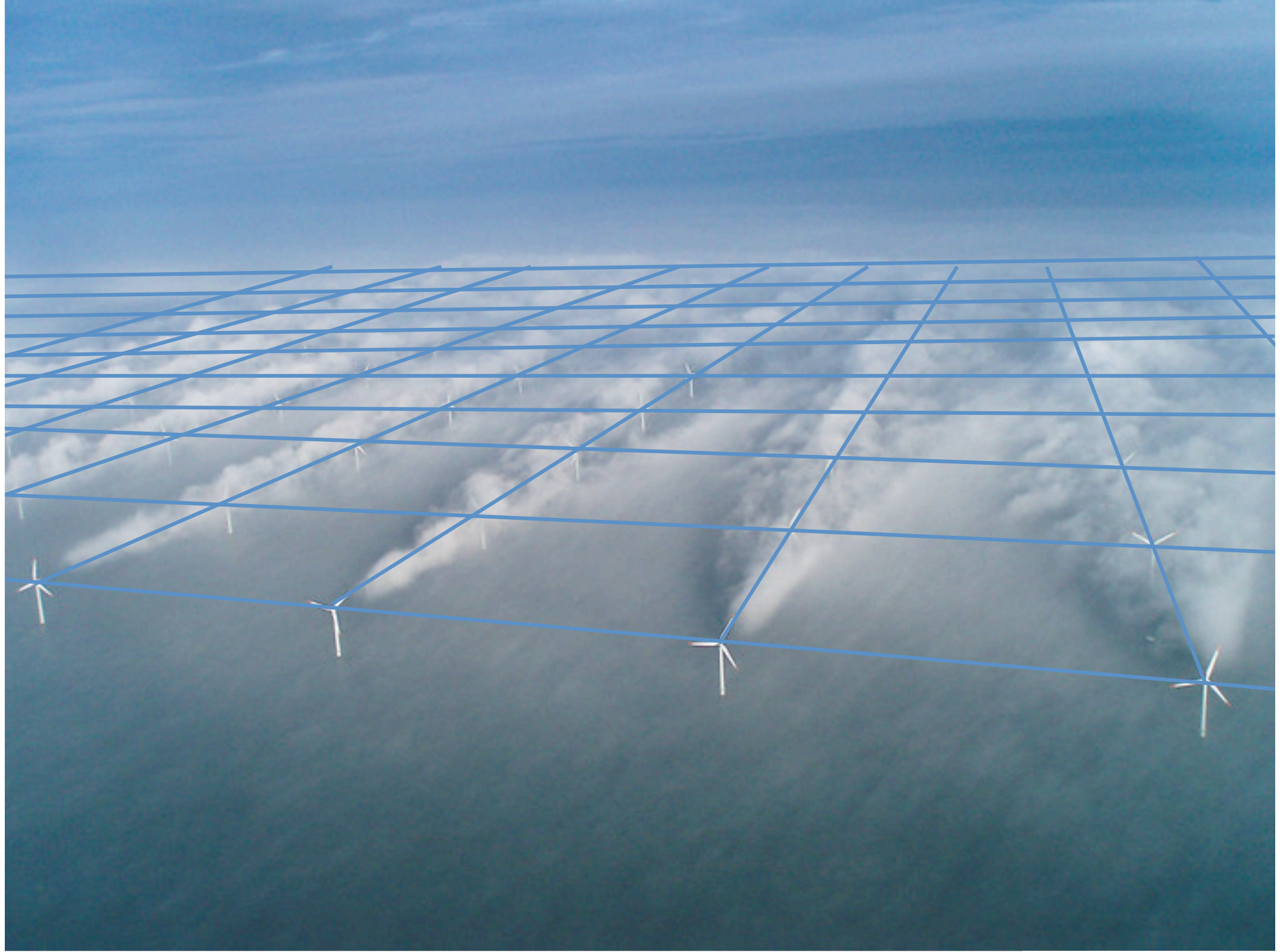
Background

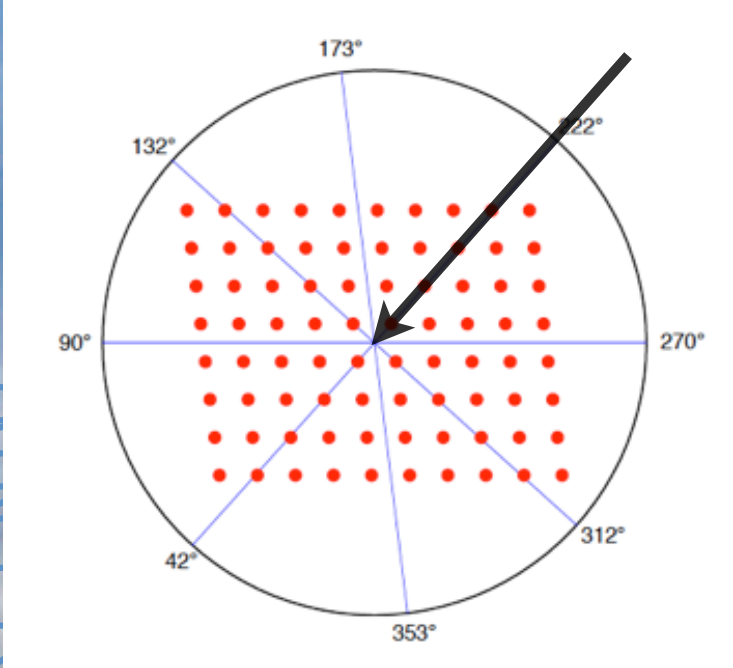
- EU/FP7/ICT sponsored project - STREP
– Networked Embedded and Control Systems
- 6 partners:

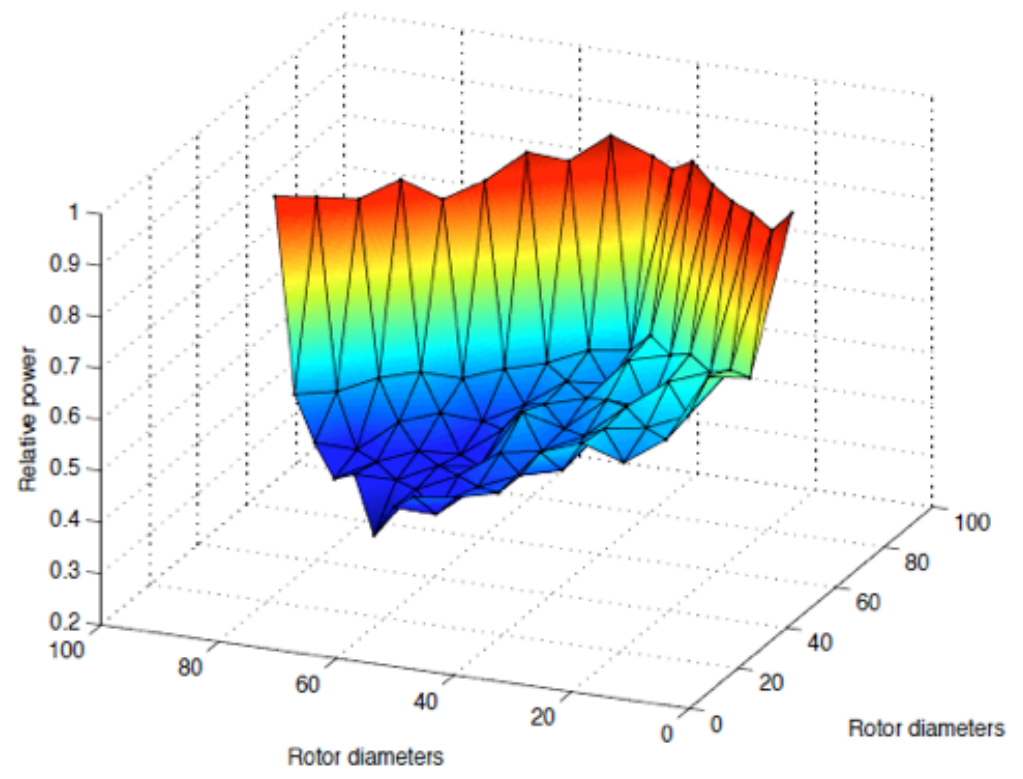
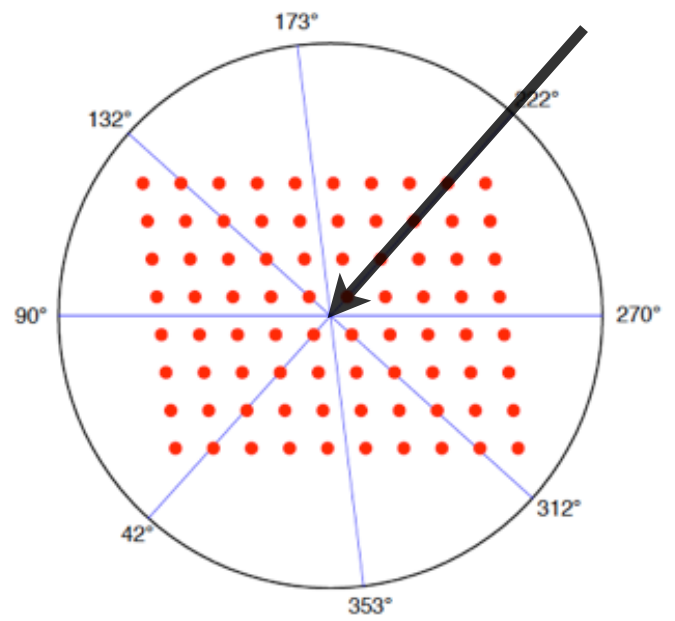


- Budget: € 3.5 mill (2.5 mill funded)
- Duration: 3 years
- W: www.ict-aeolus.eu





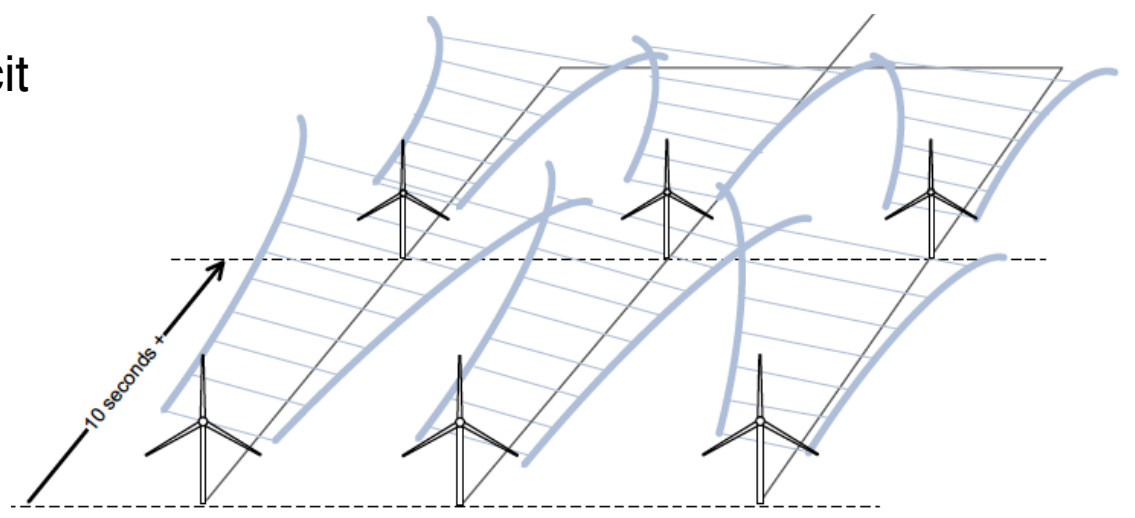




Background

- To operate wind farms cost effectively (power production and lifetime cost), modern control must be applied at the wind farm level.
- When a turbine extracts power from the wind, it disturbs the wind flow behind it and creates a coupling with turbines operating in its wake (near or intermediate wakes).

- Mean wind speed deficit and an increased turbulence level.
- Upwind turbines limit power production and increase fatigue loads on downwind turbines.



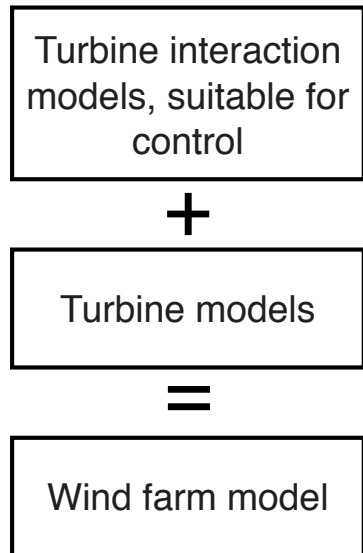
- Generally the problem has received little attention from the control community
 - [Steinbuch et al 1988] showed a gain by de-rating, maximizing the energy capture.
 - The more general lifetime cost problem was discussed in [Pao and Johnson 2009, Spruce 2003].
- Difficulty in obtaining wind farm wake models suitable for control design
 - Field models are computational expensive and kinematic models assume uniform thrust coefficients

Control problem formulation

- Consider a scenario where a farm of N turbines, is asked to produce a certain power P_d .
- The objective is to dynamically redistribute power refs in order to minimize fatigue damage, maintaining the P_d .

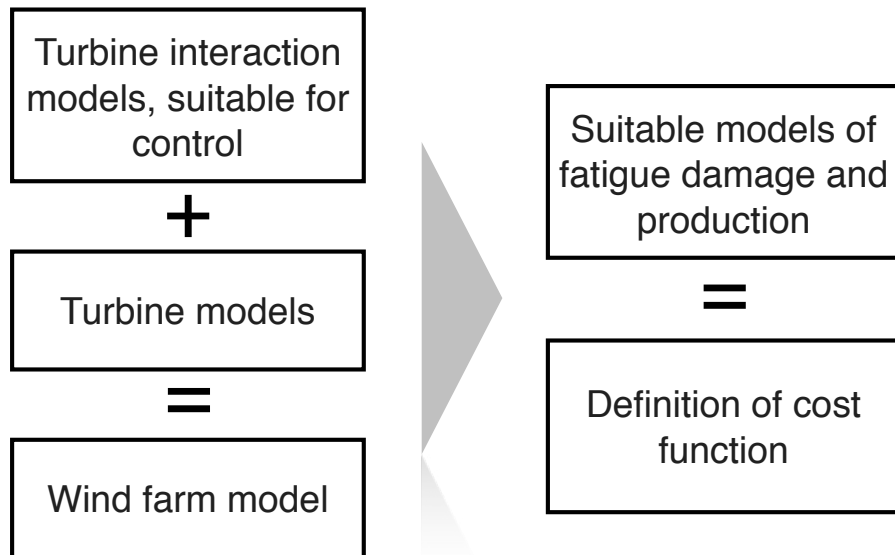
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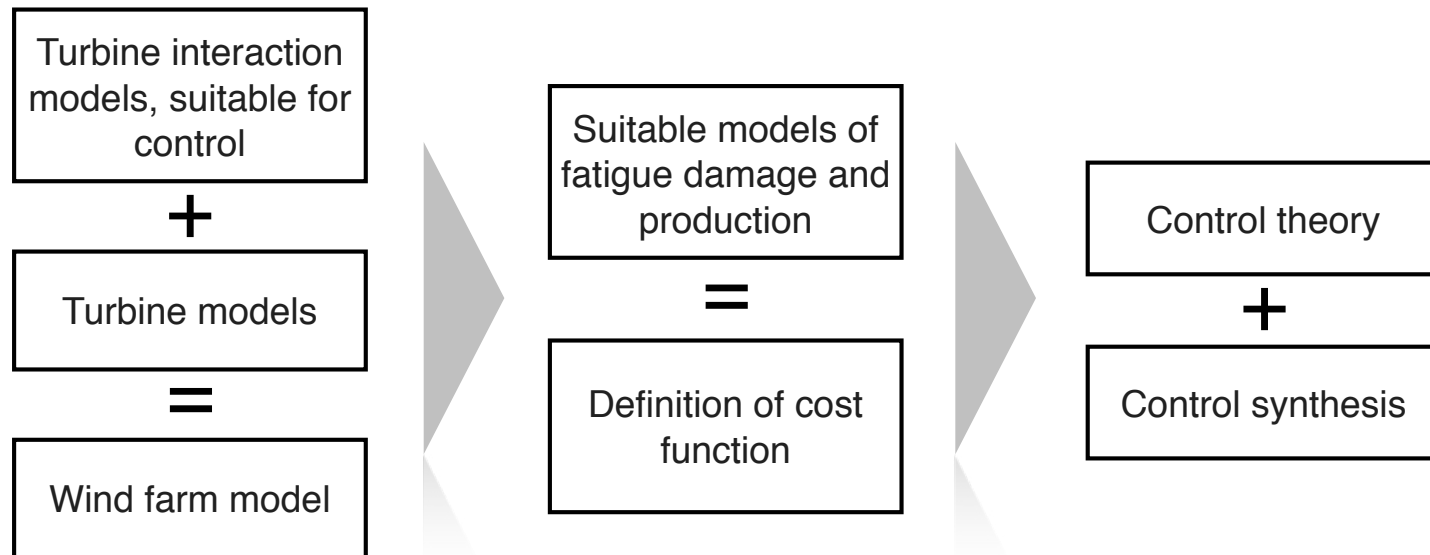
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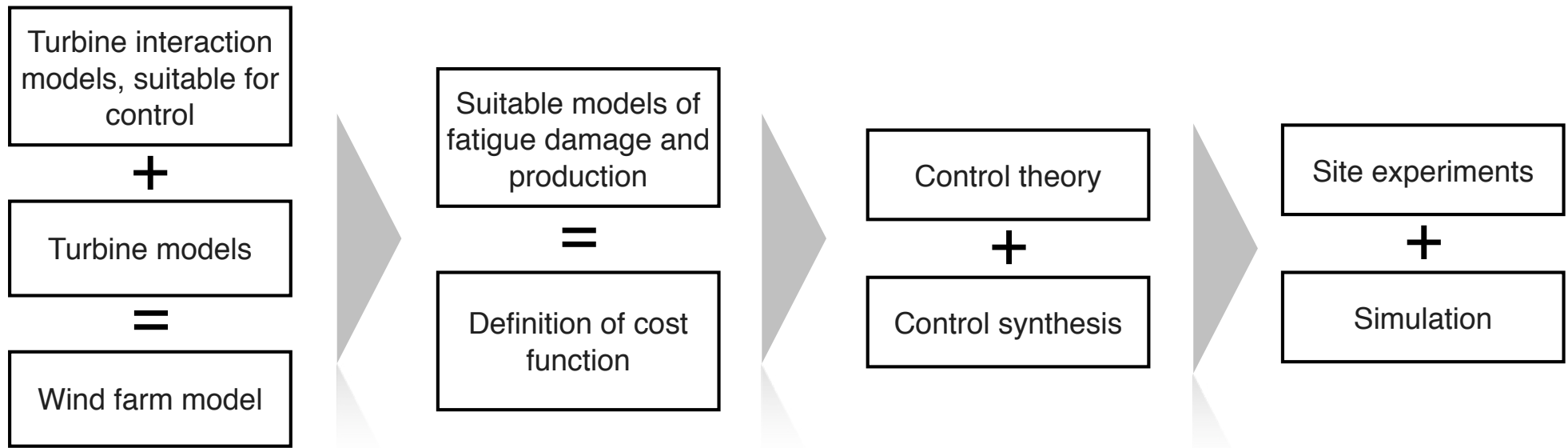
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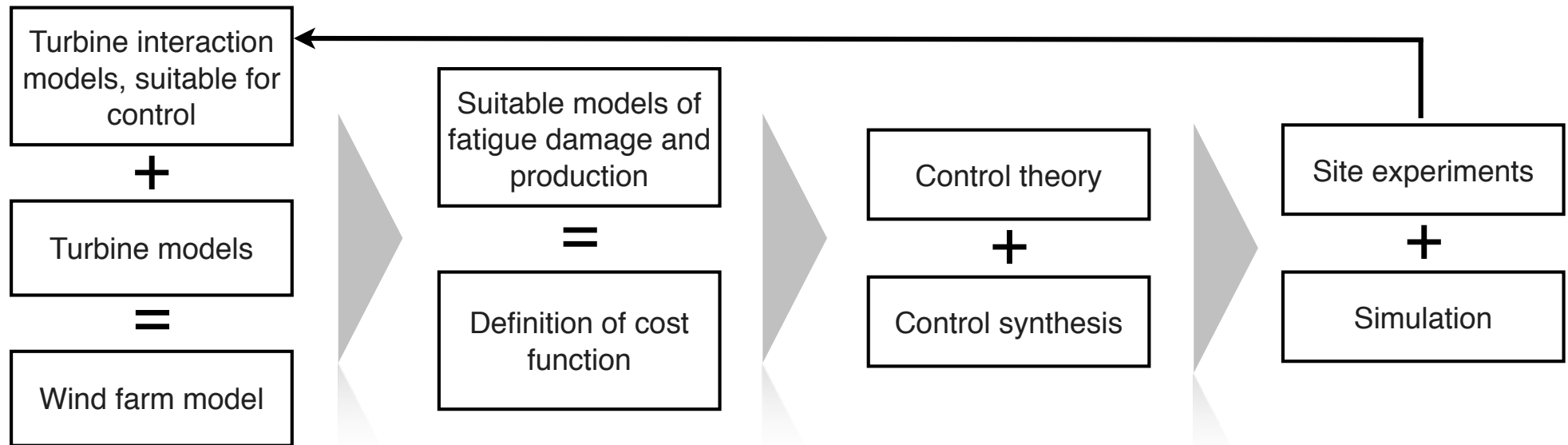
Control problem formulation

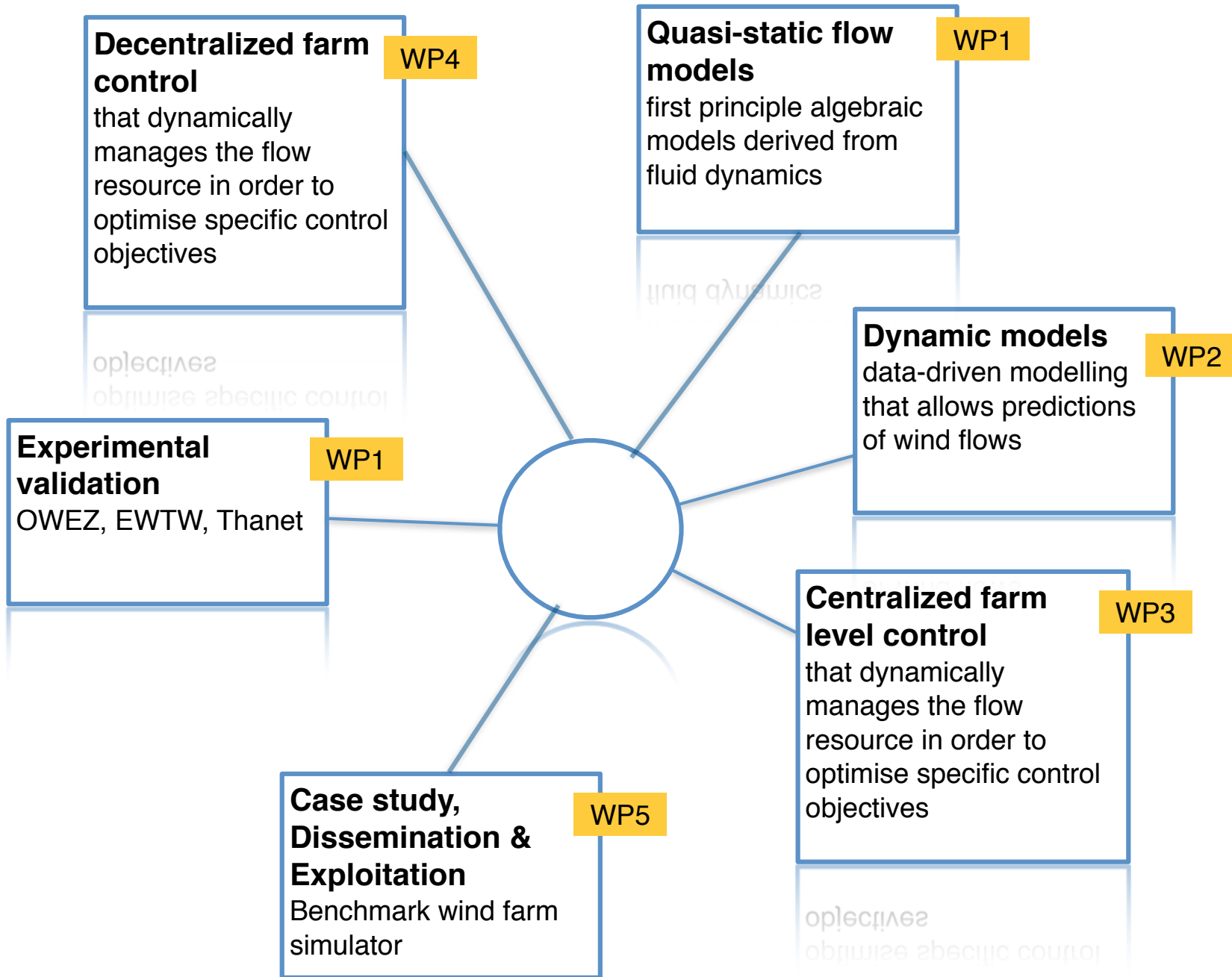
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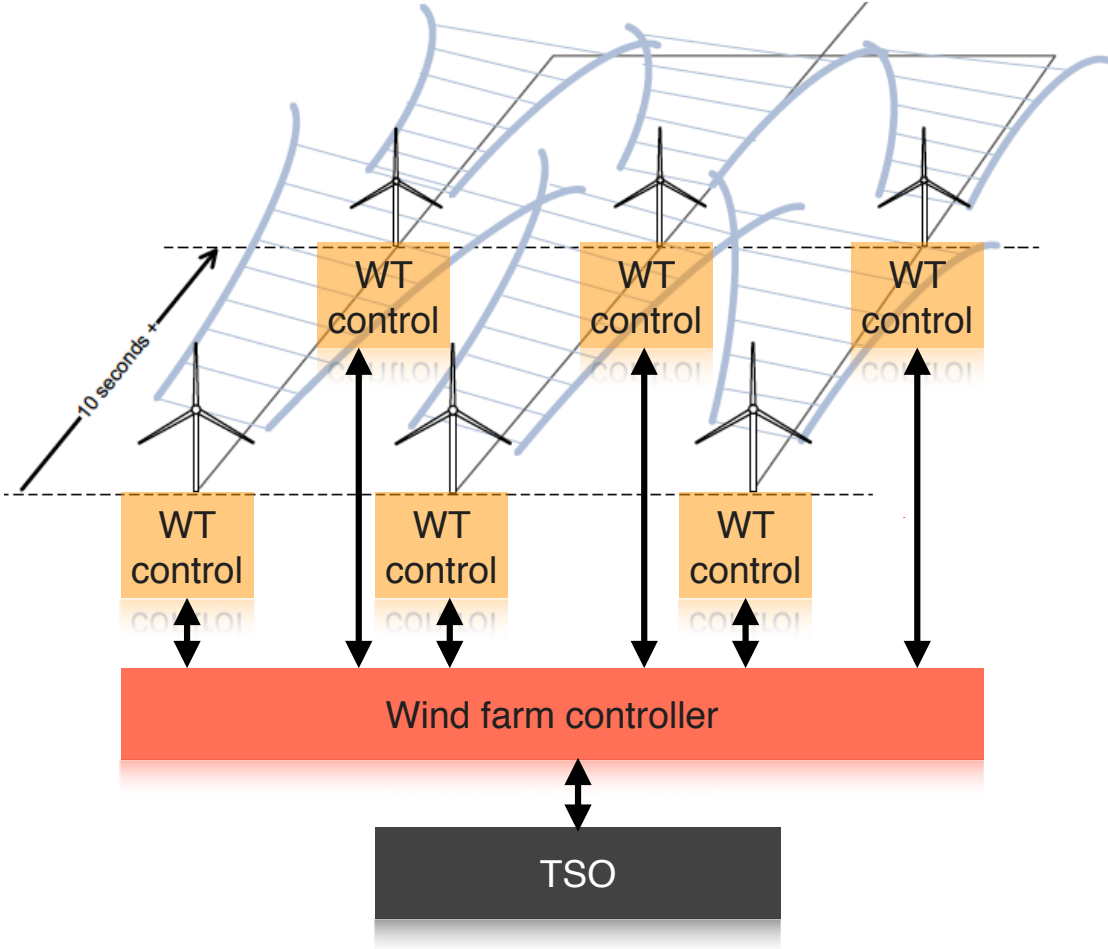
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Baseline



And now...

- Wind farm flow modeling....
- Wind farm control concepts....
- Farm control demonstration....

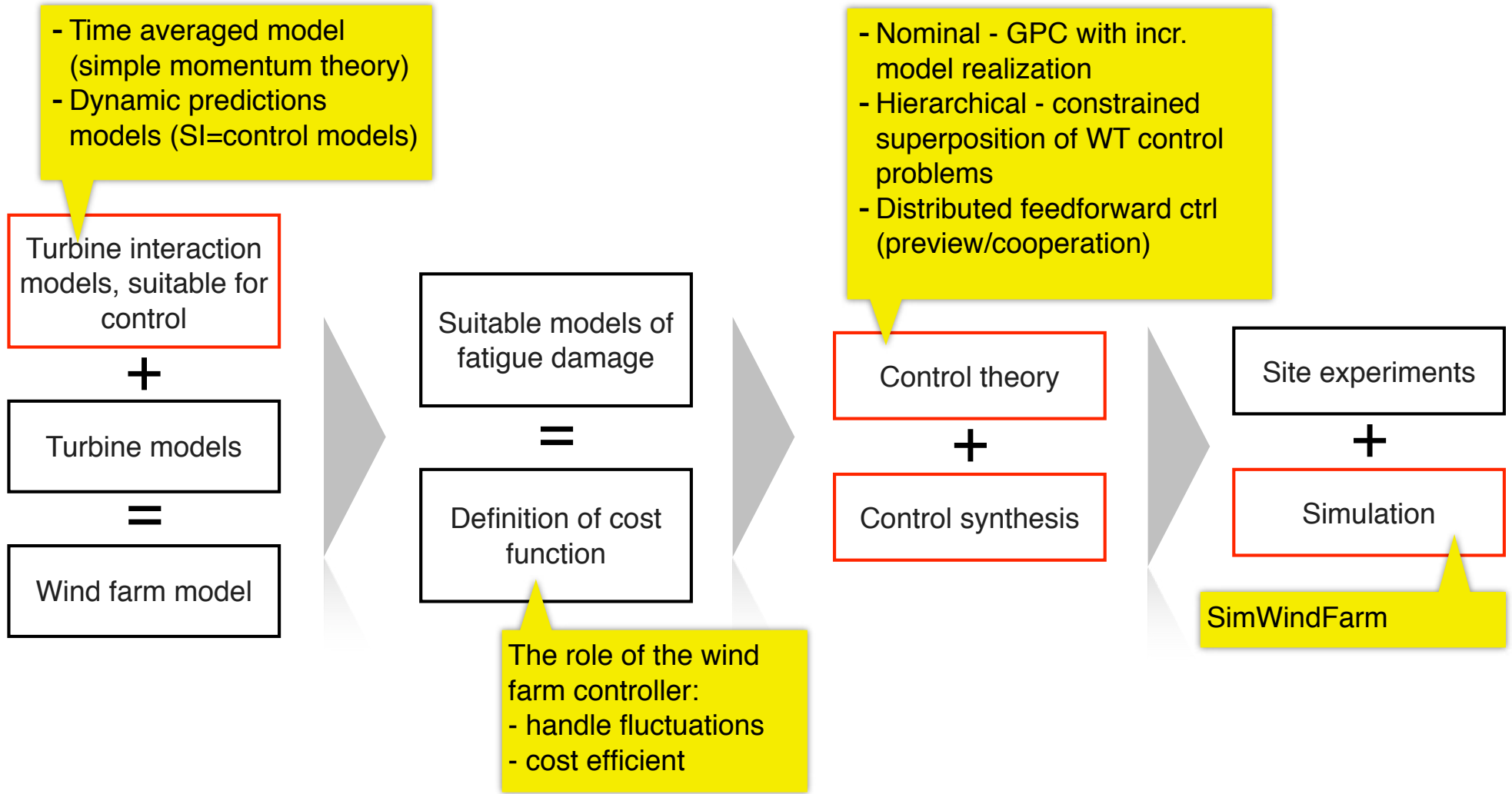
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Summary and outlook

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Summary



- Time averaged model (simple momentum theory)
- Dynamic predictions models (SI=control models)

- Nominal - GPC with incr. model realization
- Hierarchical - constrained superposition of WT control problems
- Distributed feedforward ctrl (preview/cooperation)

Conclusion

- Focus areas:
 - Models, control (hierarchical distributed/central) and validation
- Models suitable for control formulated
- Wind farm level control problem formulated
 - Focus on minimizing fatigue damage, meeting power demand
 - Cost functions defined
- Benchmark wind farm simulator
- Site-experiments on Thanet Q2-Q3 2011



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Thank you.
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