New configurations at DLR

5th Symposium on Collaboration in Aircraft Design
12th-14th October 2015

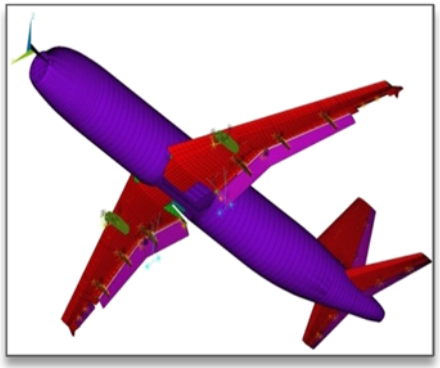
Dr. Thomas Zill

DLR

Outline

- Overview of A/C configurations at DLR
- Collaborative A/C design
  - Central data model CPACS
  - Distributed analysis approach
  - Flexibility of design multifidelity workflows
- Collaboration on Boxwing aircraft

Aircraft configurations at DLR



D100, D150, D250, XRF1
VAMP, DIGITAL-X,
iGREEN, AGILE, CS2

D150-FSW LAMAIR
iGREEN

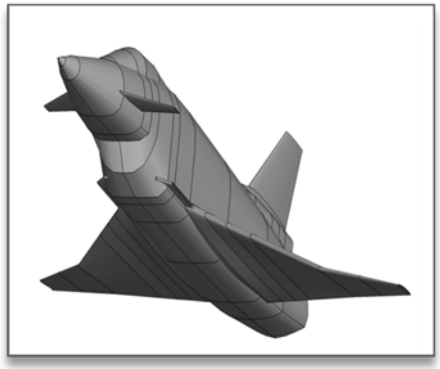
D150-SBW-OR
FrEACs, PEGASUS,
iLOADS, AGILE, CS2

D150-BW, D250-BW
HIRG, iLOADS, AGILE

BWB
AP2030, FrEACs,
AGILE, CS2

HybridElectric
FAIR-IP, AGILE, CS2

FanWing
SOAR

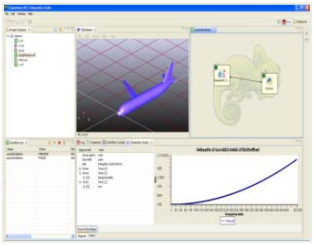


Mil-AC
IDEaliSM

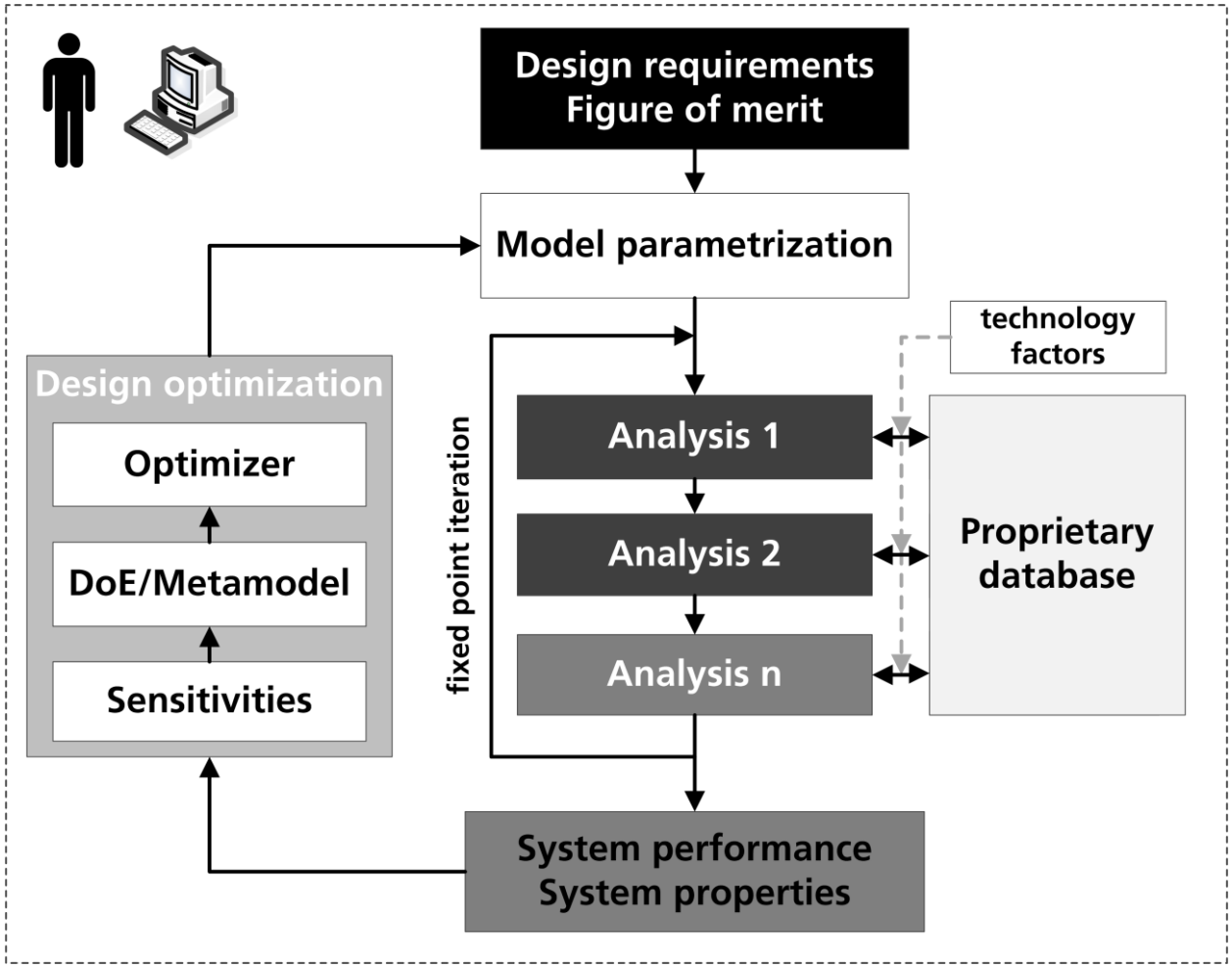
A/C analysis/design is a collaborative effort in internal and international projects
What is the backbone for collaboration on a technical level?

Collaborative Aircraft Design

Merging Competences



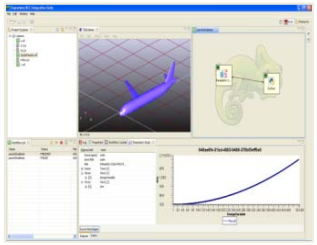
Engineering framework RCE



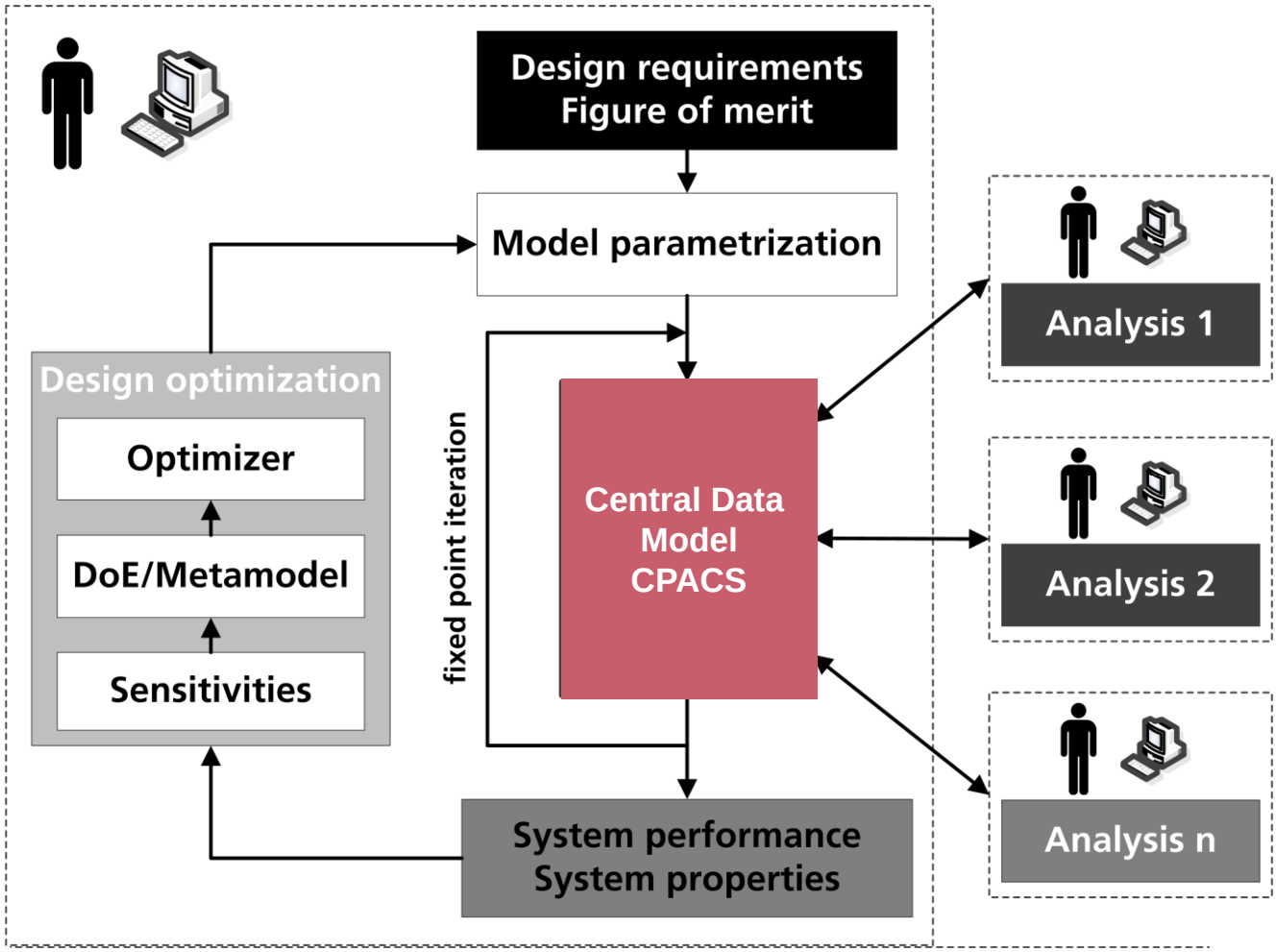
- standard approach for most pre-design & analysis systems
- single user performing analysis
- ideally knows each component of system by heart
- you can‘t be a specialist in every discipline

Collaborative Aircraft Design

Merging Competences



Engineering framework RCE

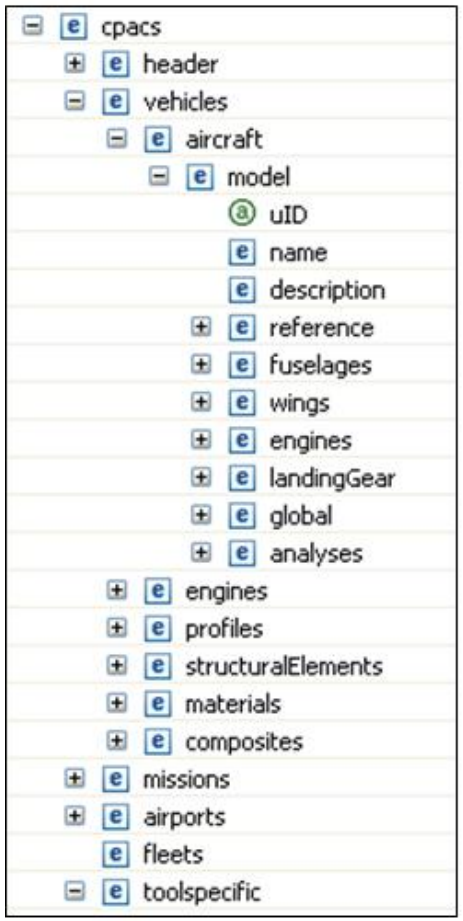


- distributed, collaborative approach
  - Integrator
  - specialists
- central common data model *CPACS*
- specialists provide analysis components
- flexibility in setup of workflows

Collaborative Aircraft Design

Common data model CPACS

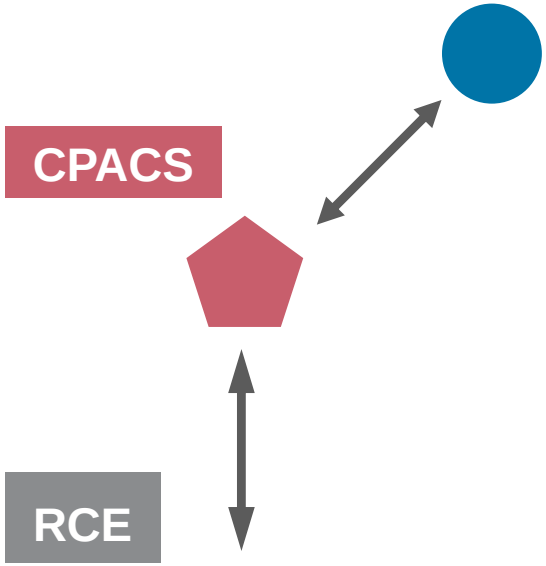
CPACS

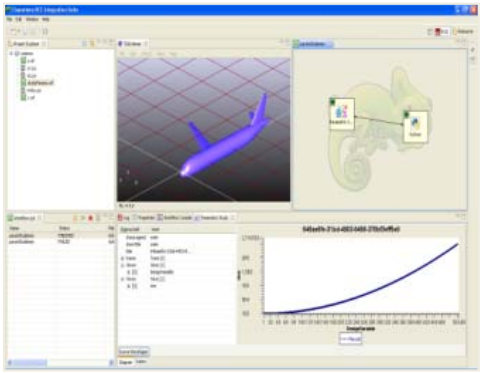


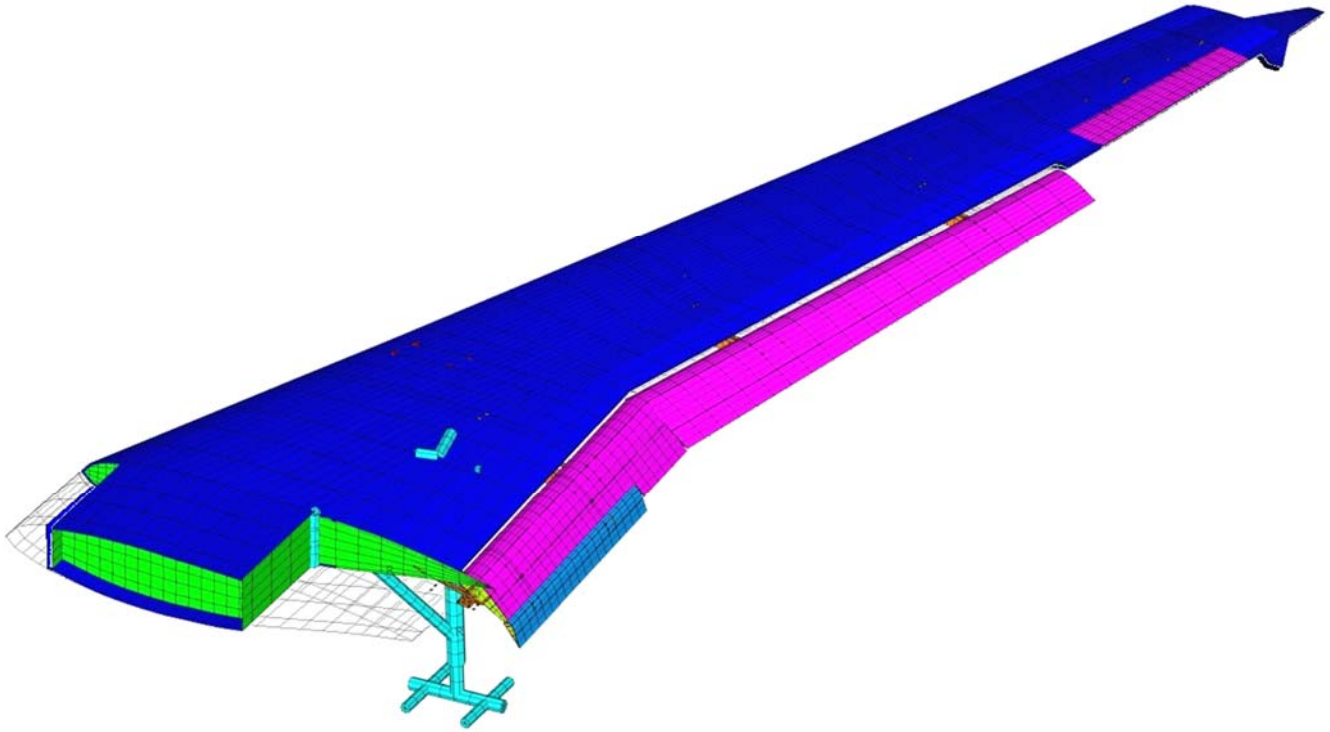
- Common Parametric Aircraft Configuration Schema
  - xml-based, human-readable
- Data model holds information on:
  - product: geometry, performance…
  - process: triggers, analysis options…
- under continous development at DLR since 2005
- enables: a) multidisciplinary analysis
  b) multifidelity analysis
  c) multiscale analysis

A common data model facilitates multidisciplinary analysis

CPACS



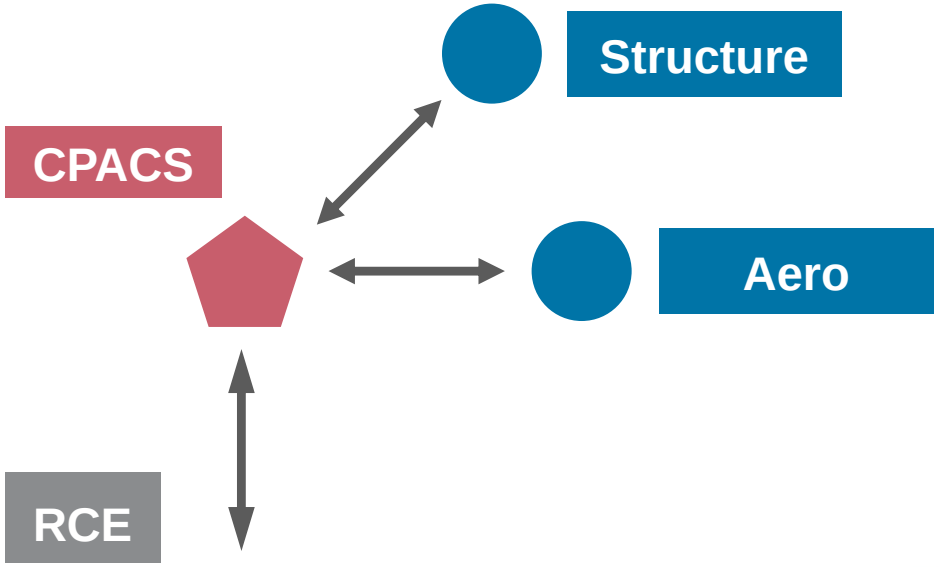


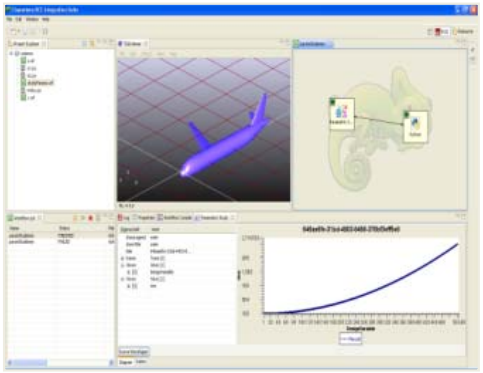


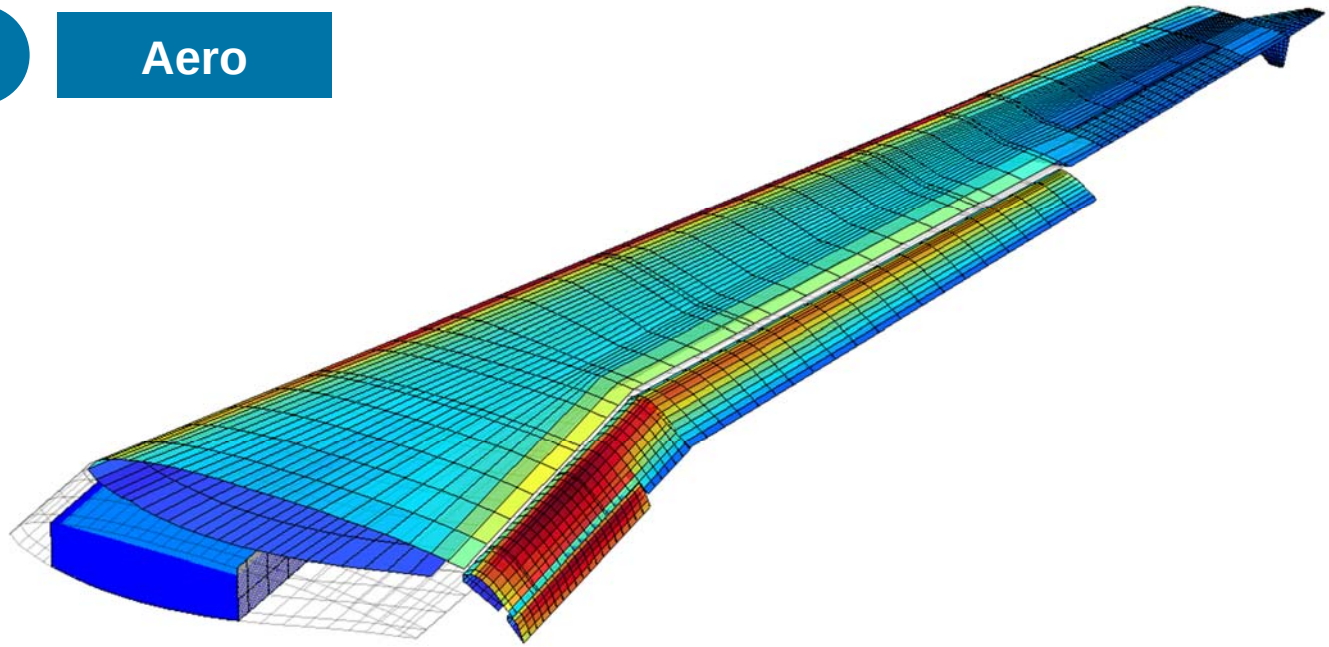
Does such collaborative approach really work in a company with many distributed sites?

A common data model facilitates multidisciplinary analysis

CPACS







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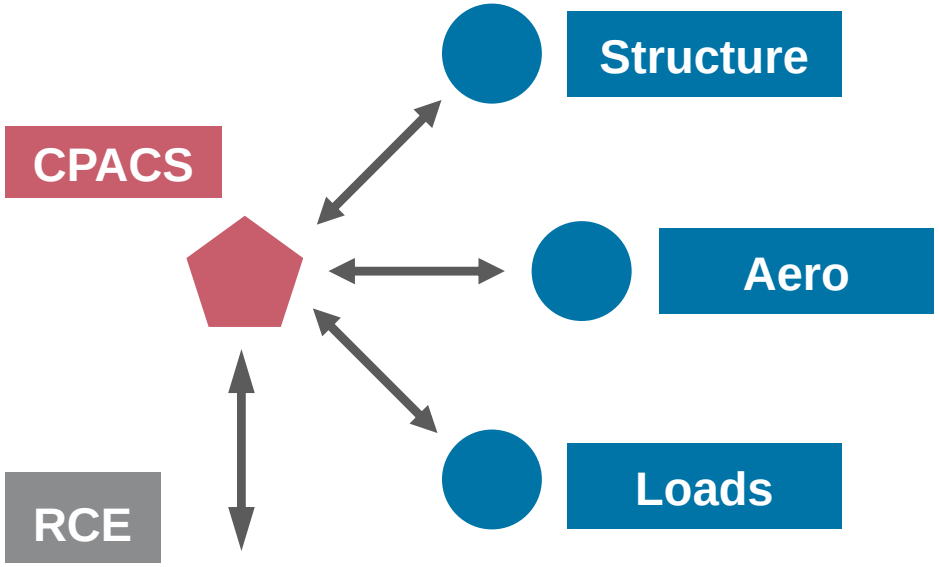

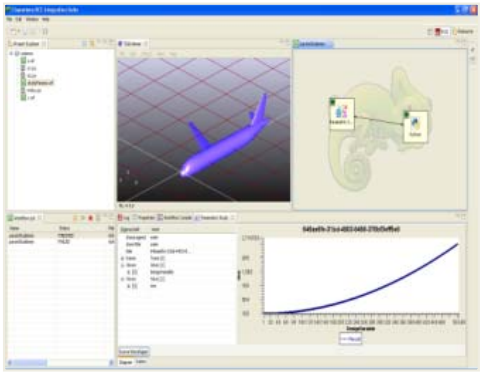

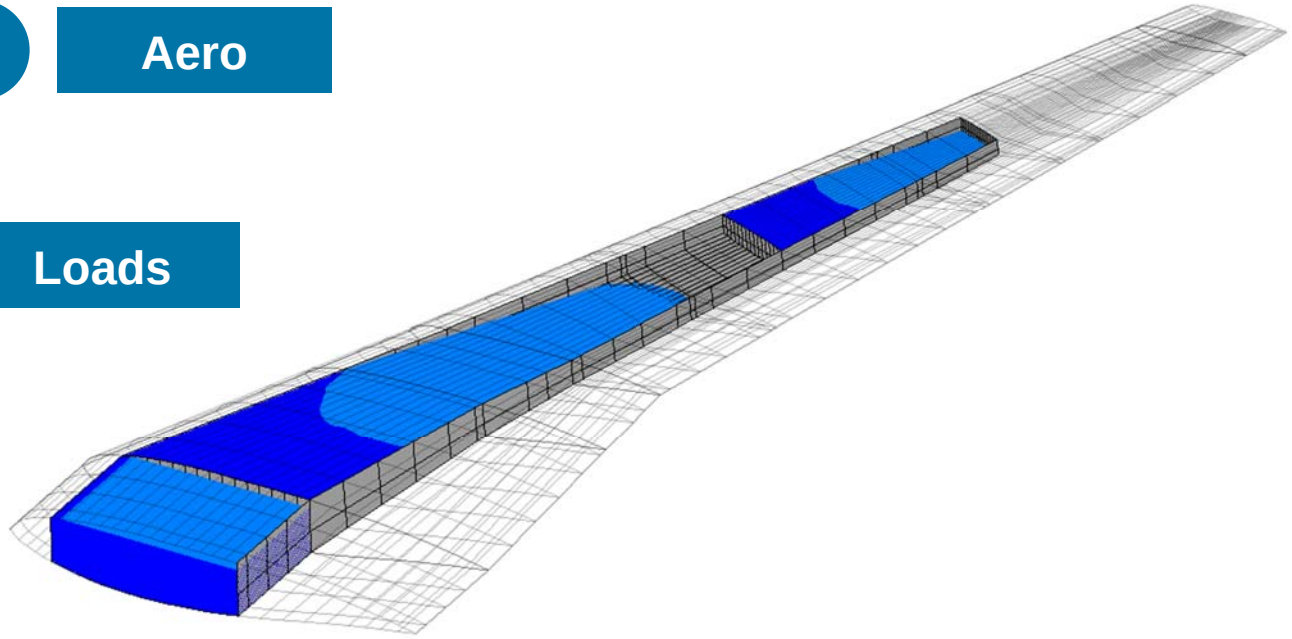

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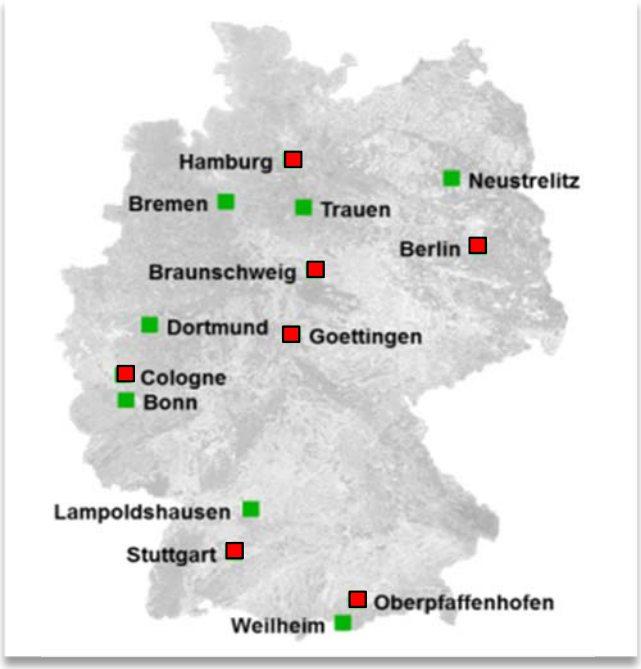
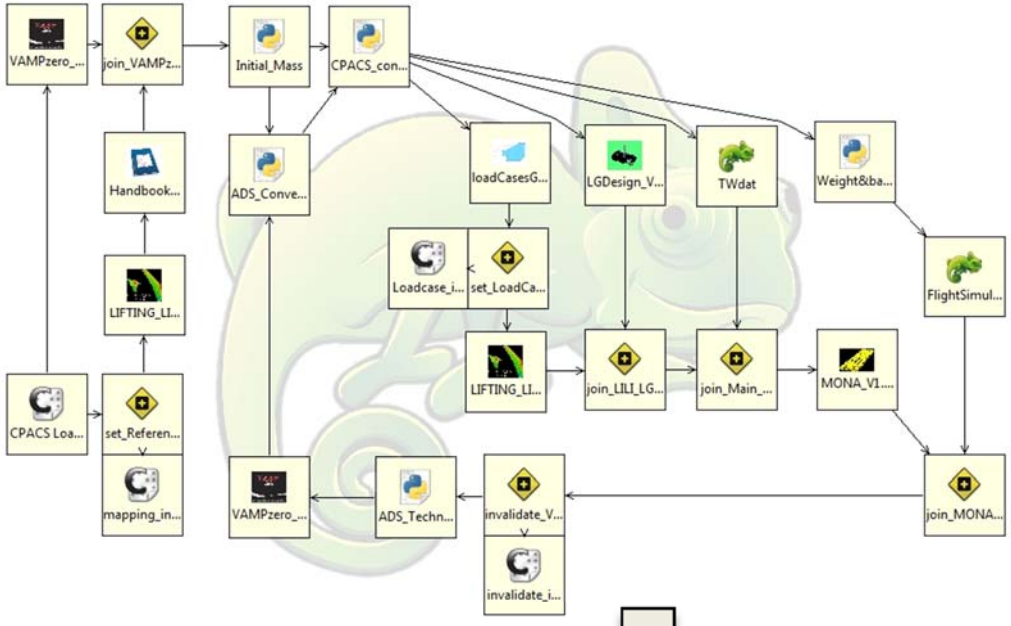
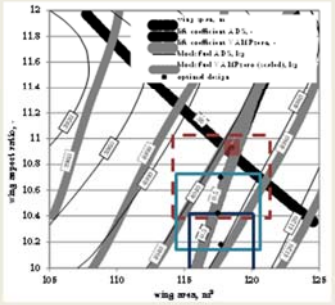
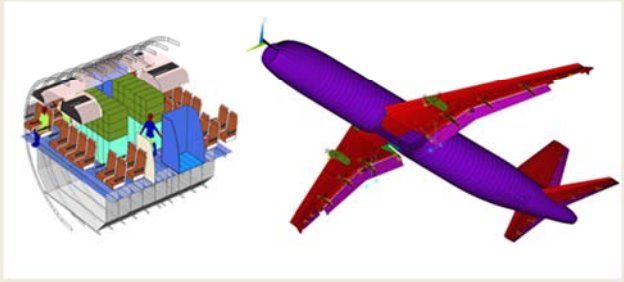
Distributed collaborative analysis at DLR





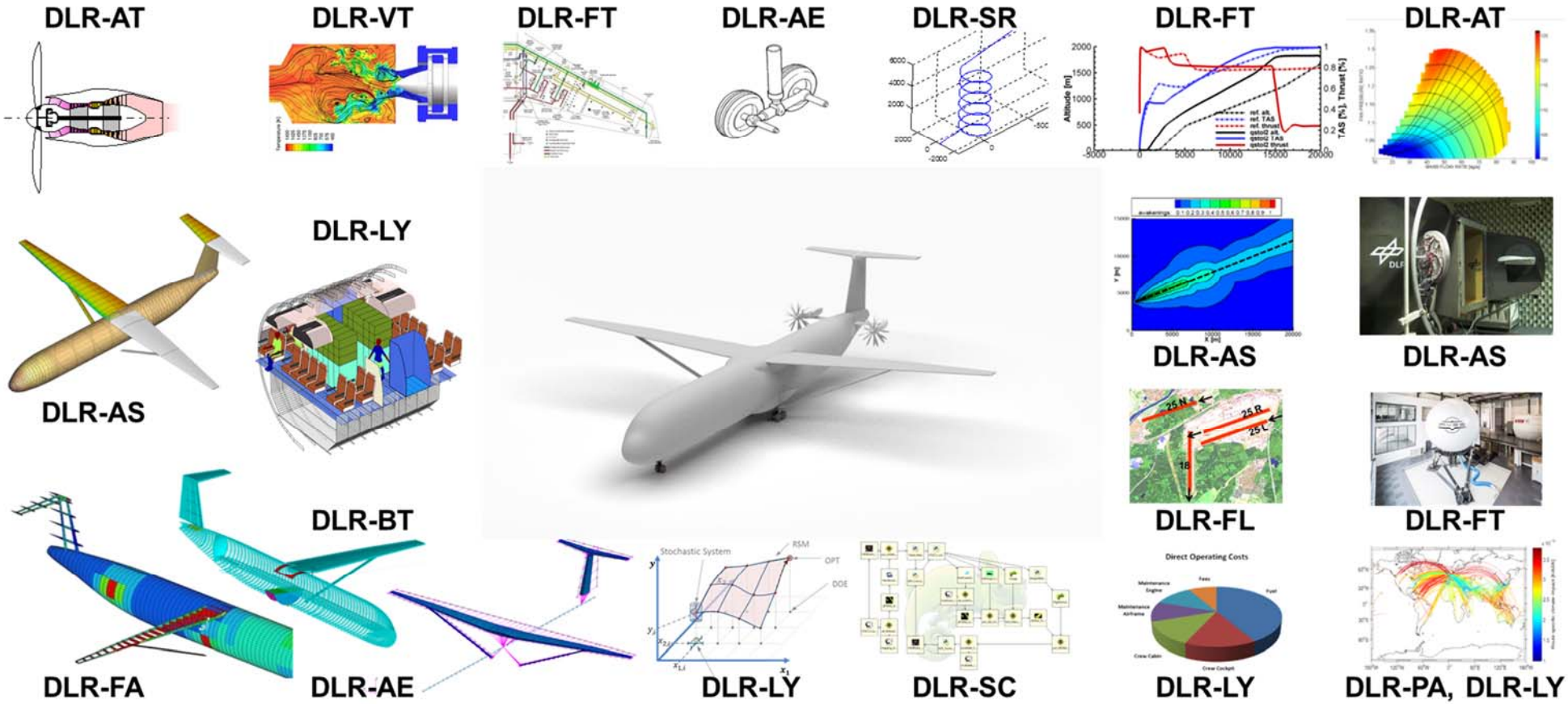
- Aircraft design process established at DLR
- Analysis components located at distributed DLR-sites





Collaboration enables detailed insights

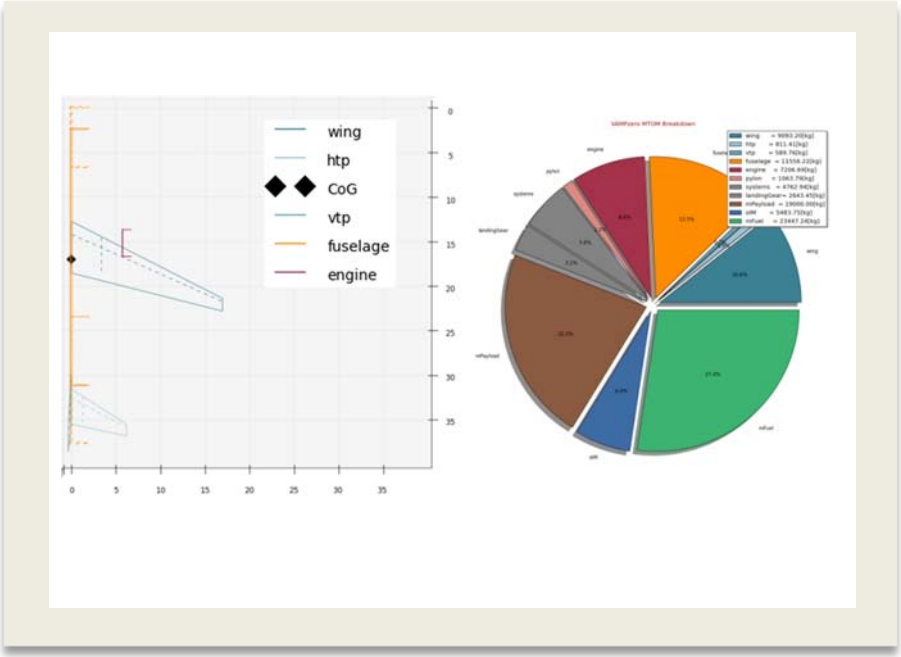
19 DLR Departments Collaborate in Internal FrEACs Project

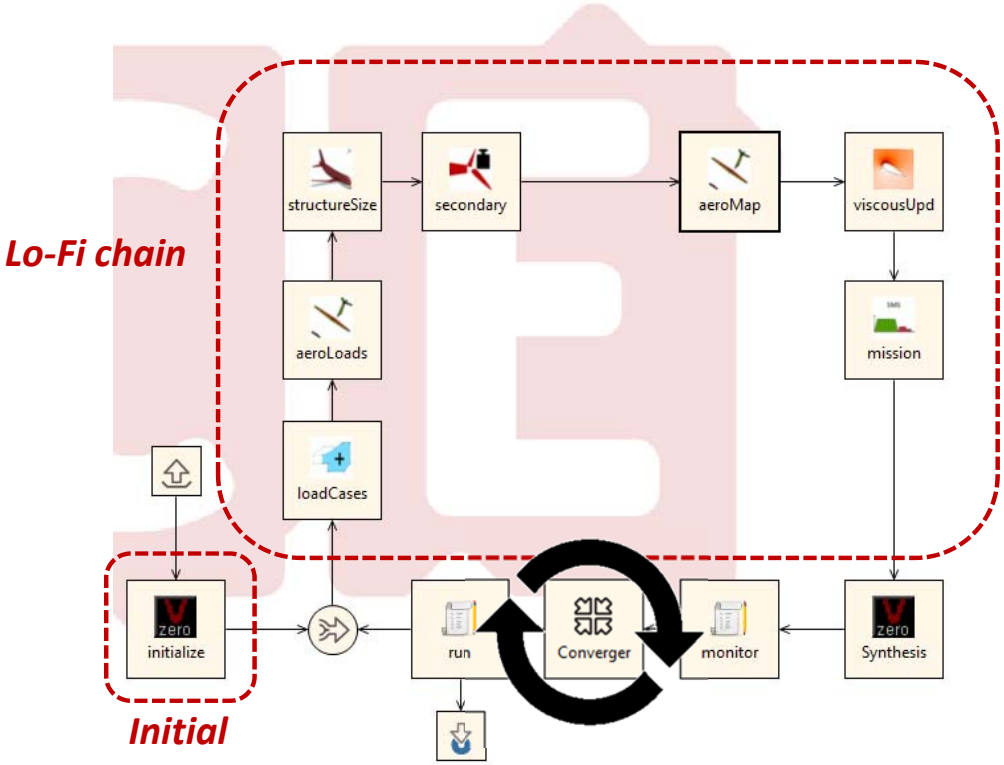


Tools are just a means to coming to a conclusive result

Integrating Disciplines

Loads Process in Pre-Design





Module Details: ***Initialization of the Design***

→Conceptual Synthesis from TLAR to initial design

→Components sized by empirical\statistic (e.g. LTH masses)

Module Details: ***Geometry handling and model generation***

→Geometry as CPACS definition forwarded to Lo-Fi physics based analysis

→Disciplinary models extracted by generators based on TiGL geometrical kernel

Integrating Disciplines

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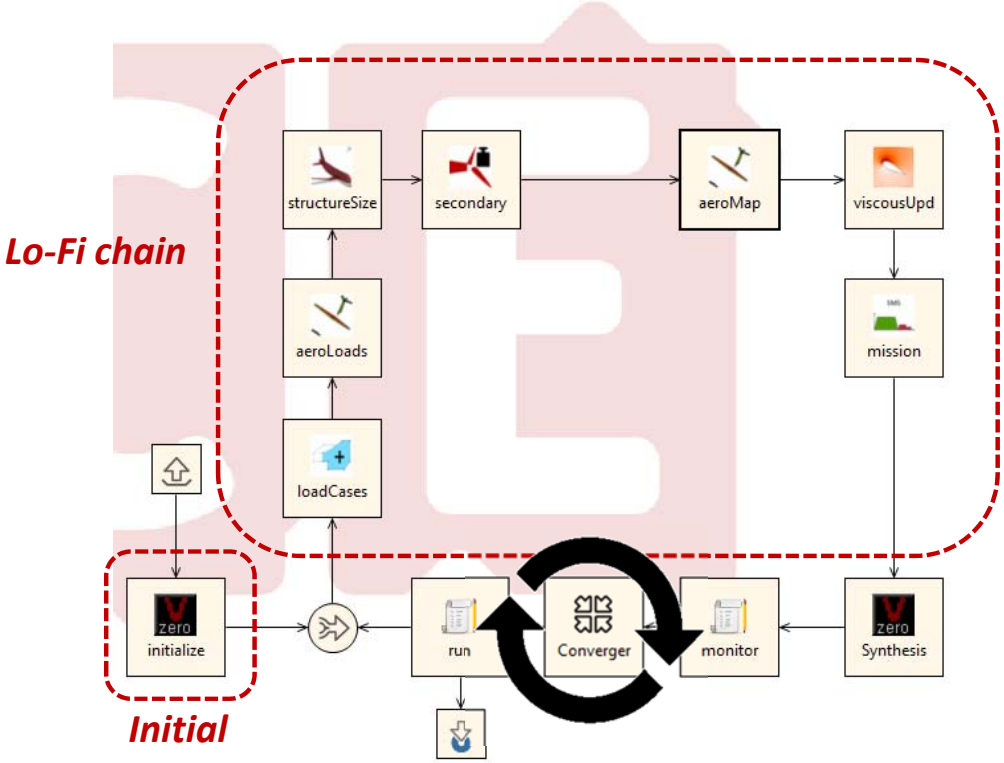


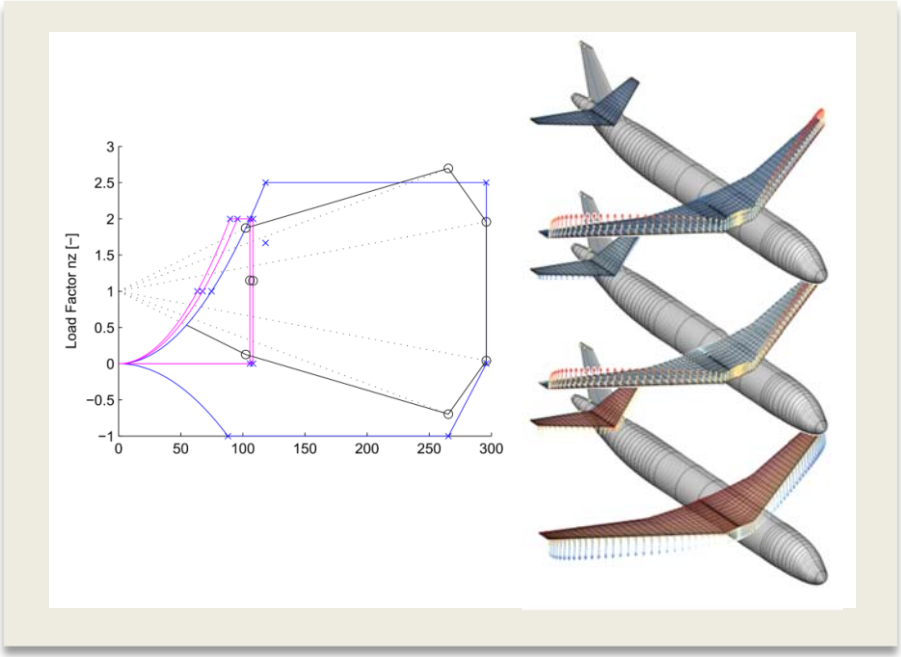
Module Details: ***Flexibility loop***

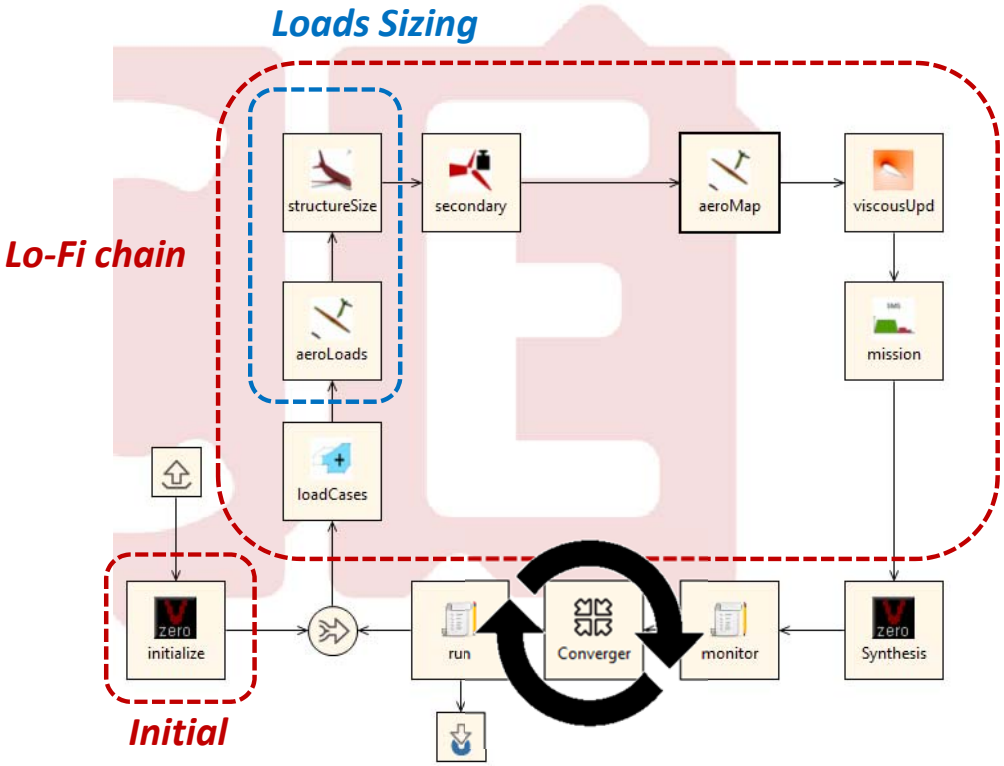
→Aircraft performance corrected by aero-structural flexibility effect

→ FSI coupling schemes based on MLS\RBF for forces-displacements transfer

Integrating Disciplines

Loads Process in Pre-Design





Module Details: ***Lo-Fi aerodynamics analysis***

→Lo-Fi aero model for performance calculation at mission points (VLM+ based)

→ Multiple Loads Cases for sizing: maneuvers and gust loads

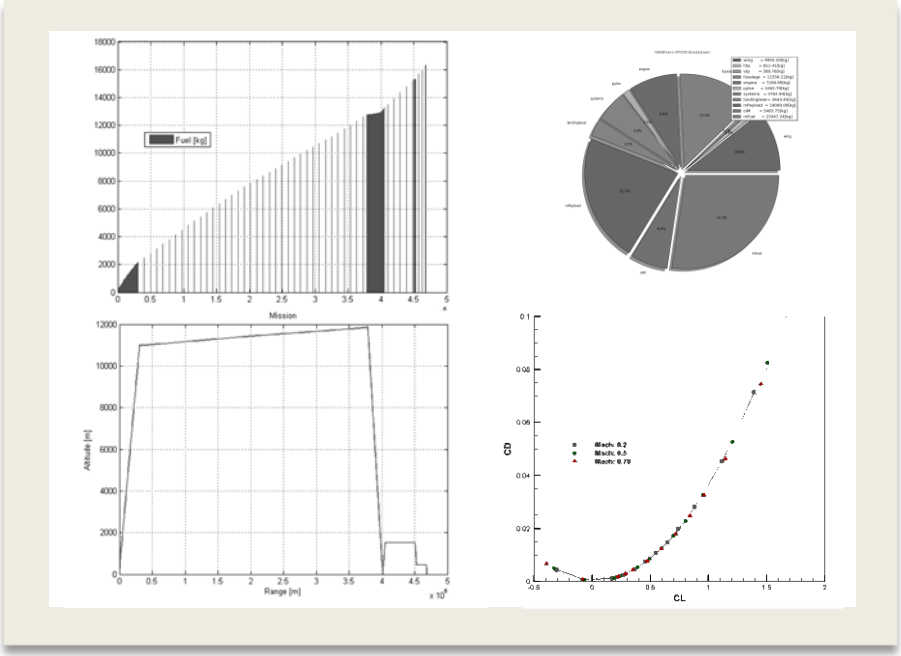
Module Details: ***Lo-Fi structural analysis***

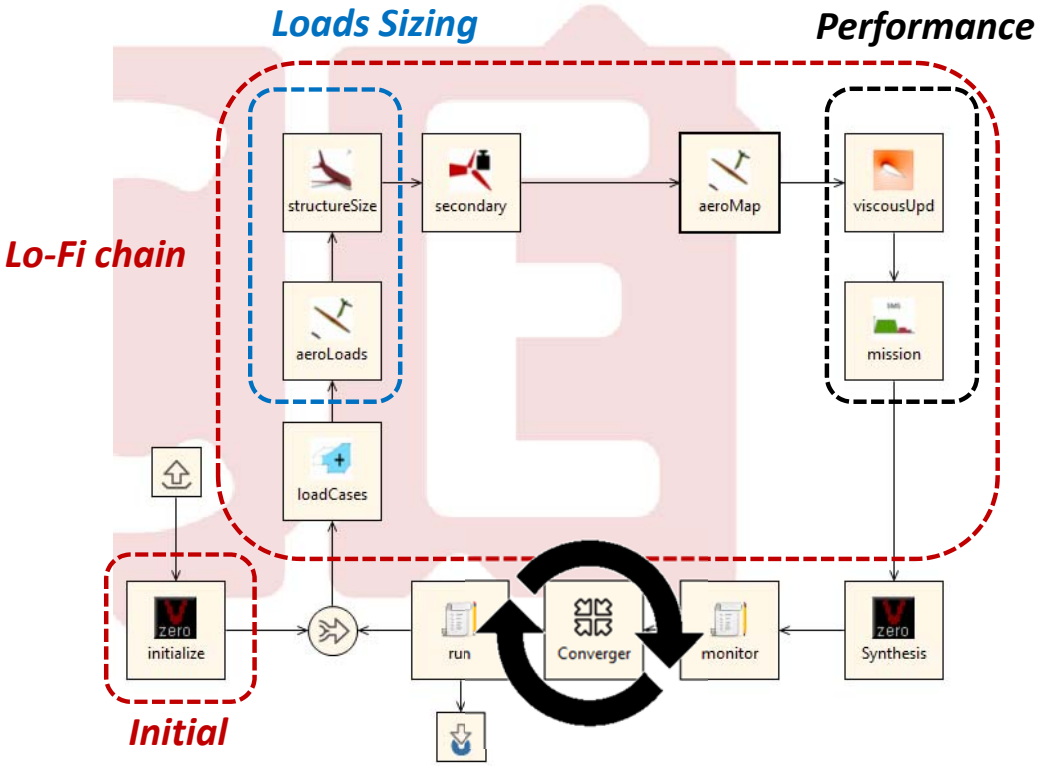
→Lo-Fi structural model for sizing of primary structures (FEA bases)

→Sizing based on strength\buckling criteria, static analysis

Integrating Disciplines

Loads Process in Pre-Design





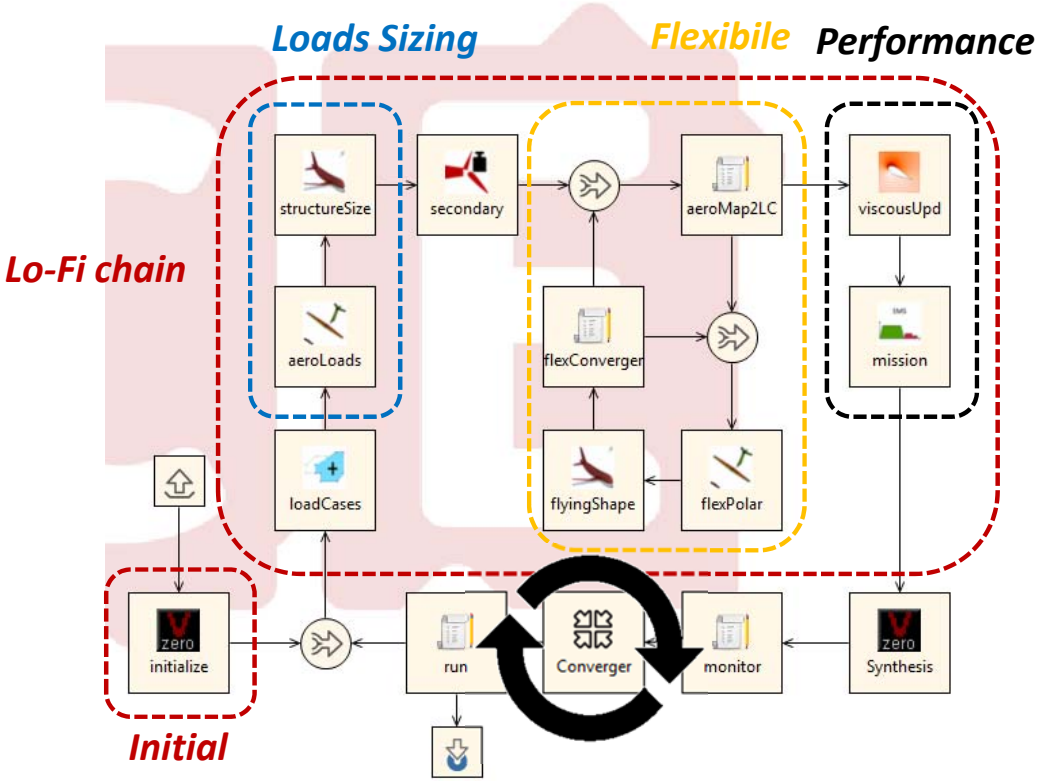
Module Details: ***Mission analysis***

→Mission profile and mission fuel mass

→ Based on aircraft performance calculated with Lo-Fi chain

Integrating Disciplines

Loads Process in Pre-Design



Module Details: ***Flexibility loop***

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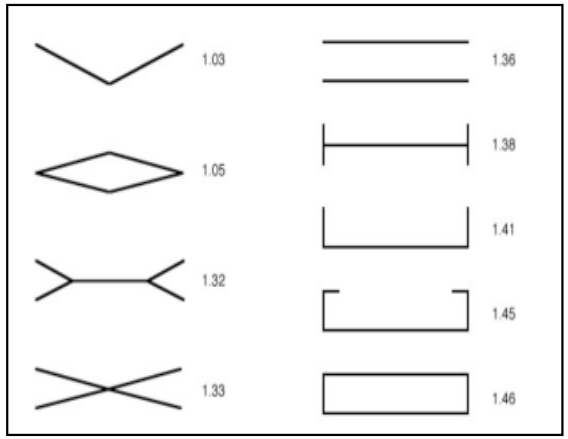
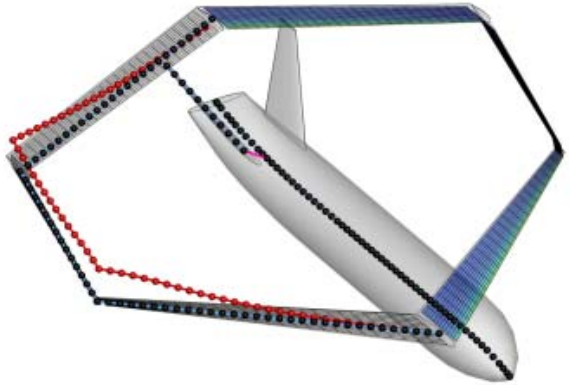
Boxwing configuration

Extension of the design space

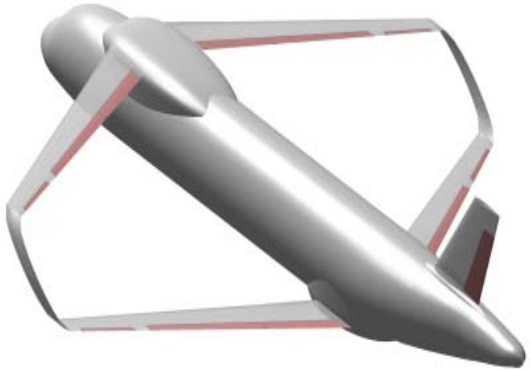
- Low induced drag/reduced wingspan
- Consideration of all relevant effects in workflow
  - Stability and control criteria drive the design
  - Loads & mass estimation require aeroelastic analysis



Efficiency factors, L. Prandtl (1926)



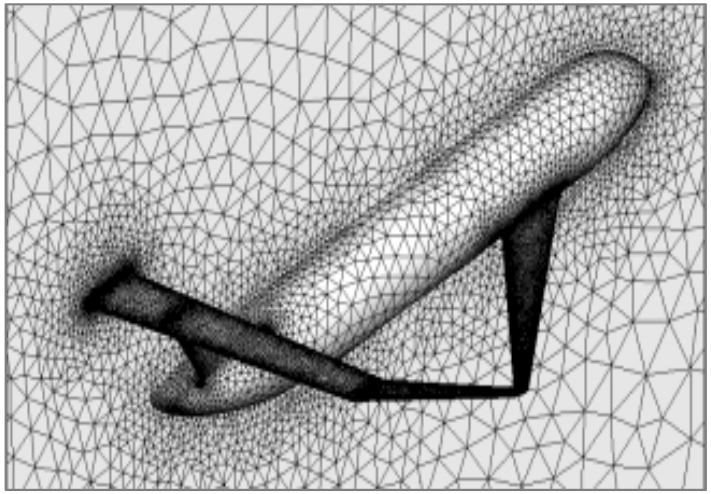
Full aeroelastic model



Control surface layout

Boxwing configuration

Extension of the design space



- Aerodynamic results validated through WT tests
- Collaborative effort in the Helmholtz Int. Research Group *„Optimization of BoxWing Aircraft“* with Nangyang Technological University, Singapur

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