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ICARE: A joint initiative for transferring Non Intrusive Coupling Techniques towards Industry

S. Guinard[1], **M. Abbas**[2]
[1] Airbus Group Innovations, BP 90112, 31703 Blagnac Cedex, France, stephane.guinard@airbus.com
[2] EDF Lab Paris Saclay, 1 avenue de la Vauve, 91220 Palaiseau, France, mickael.abbas@edf.fr

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ABSTRACT

Before meeting its full potential in industry, computational mechanics will have to overcome two major limitations that still prevent from further release of promising capabilities:

- deriving models from CAD is too long, particularly for complex engineering systems such as aircrafts or power plants; though 'non-value-added' activities are largely outsourced by large companies, induced time cycles and costs for updates of Finite Elements (FE) models are prohibitive items when promoting more simulation into industrial processes;
- linking models at various scales, in various disciplines, is still far from grasp; most multi-scale analysis are limited to one-way descendant schemes with no feedback on how local non-linearities may influence the global behaviour; multi-physics couplings are partially captured through few iterations of sequenced mono-disciplinary computations.

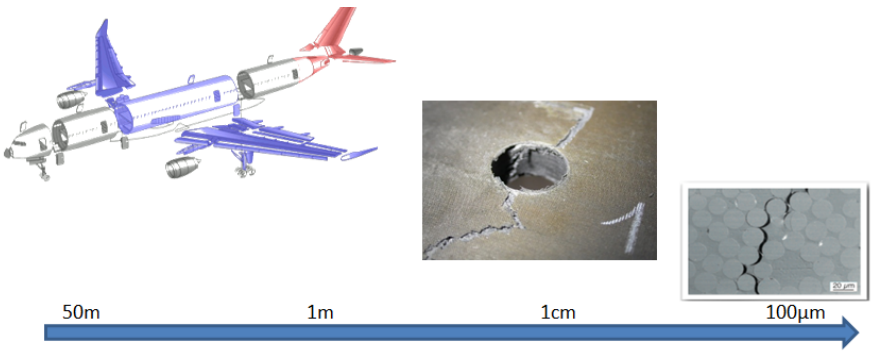

Figure 1: Characteritic lenghths to be investigated in multi-scale analysis of aero-structures.

The concept of non-intrusive coupling emerged from [1] and sparked a joint initiative, ICARE, with EDF and AIRBUS as industrial partners - sharing actual numerical issues extracted from real life practices -, and aknowledged partners in complementary disciplines (DISTENE, LMT-Cachan, UTO, GeM) - adapting the initial idea to a set of critical situations met in industrial use-cases. ICARE (Generalized interfaces and non-intrusive coupling between R&D and standard software for computational mechanics) is an ANR granted project (ANR-12-MONU-0002,

2013 $\rightarrow$ 2016) that aims at developing numerical techniques in order to simulate the behavior of large and complex structures: thanks to these techniques, stress engineers will be able of investigating tiny structural details at local scale while keeping their preferred generalist tools at global scale (non-intrusive requirement). A major benefit of ICARE will be to facilitate the dissemination of R&D tools: by making coupling easy, operating specialized R&D software within an industrial framework will be made possible.

Most of herein evoked numerical methods will be discussed further in accompanying papers of mini-symposium "coupling methods for the local enrichment...". The present paper focuses on:

- **industrial challenges underscored by ICARE**, in different situations where aforementioned issues are critical bottlenecks;
- **implementation strategy settled by the consortium**, involving EDF support in transferring methods into Code_Aster [5], an open source FE software qualified by the French nuclear authority for industrial studies, meeting all standard requirements for software development and maintenance;
- **capabilities demonstrated today**, with illustrations on recent achievements in different domains: multi-scale analysis with no operation on global mesh, with domain decomposition capabilities [2], with coupling of specialized R&D software dedicated to composites [3], dedicated to crack analysis [4];
- **prospects for continued efforts in disseminating** ICARE's outcomes beyond the scope covered today (structural mechanics).

REFERENCES

[1] Gendre L., Allix O., Gosselet P. and Comte F. Non-intrusive and exact global/local techniques for structural problems with local plasticity. *Computational Mechanics.* 44(2):233-245 (2009).

[2] Duval M., Passieux J.-C., Salaün M. and Guinard S. Non-intrusive coupling: recent advances and scalable non-linear domain decomposition. *Arch. of Comp. Mech. in Eng.* In Press 2014 DOI: 10.1007/s11831-014-9132-x.

[3] Guguin G., Allix O., Gosselet P. and Guinard S. Non-intrusive coupling between 3D and 2D laminated composite models based on finite element 3D recovery. *International Journal for Numerical Methods in Engineering* 98(5):324-343 (2014).

[4] Passieux J.-C., Réthoré J., Gravouil A. and Baietto M.-C. Local/global non-intrusive crack propagation simulation using a multigrid X-FEM solver. *Computational Mechanics.* 52(6):1381-1393 (2013).

[5] www.code-aster.org, finite element code for studies and research