COUPLING SYSTEM BETWEEN FDS AND FEM CODE

S.Laganà*, M.Spagnolo**, S.Gori**

*DTA Scarl, SS 7 Appia 706+300, 72100 Brindisi,Italy
**EnginSoft, Via Antonio Murri 2, 72023 Mesagne (BR), Italy

INTRODUCTION

A fire engineering strategy defines the fire safety objectives and performance requirements and all methods by which provide to ensure safety and protection.
This is applicable in several fields like:

- Civil: contemporary buildings need to maximize safety whilst exploiting modern construction techniques and delivering the architect's aesthetic vision. A fire strategy identifies the compartmentation required, fire resistance, elements of structure, fire stopping and cavity barriers, where required.

- Aerospace & Defense: various test methods, standards or guides are used to assess the fire behavior of various components used in fire zones; It is essential evaluate the fire resistance of components, equipments and structures located in "fire zones" and analyze response of materials and components to a fire interaction.

In recent years, there has been an increase in use of Fire Dynamics Simulator (FDS) for performance-based analysis in the area of structural fire research.

- FDS is a computational fluid dynamics code, developed by NIST for fire related simulations. It is a Large-Eddy Simulation (LES) code for low-speed flows, with an emphasis on smoke and heat transport from fires.

- TwoWayCode is an automated code to perform a two-way coupling between FDS and FEM using IBM (Immersed Boundary Method);
It allows to evaluate the behavior of structures under fire conditions by a two-way coupled analysis including FDS and FEM codes.
TwoWayCode is included in the FDS repository (available on https://github.com/firemodels/fds) under \path{Utilities/StructuralInteraction/twowaycode}.
It is an ongoing research activity carried out by Professor Julio Cesar G. Silva, Federal University of Rio de Janeiro.

The aim of this research activity is to contribute to make stable and reliable coupling system between FDS and FEM codes through validation tests of increasingly complex geometries with the objective to apply this technique to all connected application fields.

SYSTEM PROPERTIES

- **Windows 10 Pro**
  Processor: Intel® Core™ i5 CPU
- **System type: 64-bit Operating System, x64-based processor**
- **Intel Fortran Compiler**
  (Intel® Parallel Studio XE Cluster Edition with Intel MPI libraries)
- **Gnu make utility**
- Defined all the environment variables and paths
- **Ansys v16.2**
- **FDS, SMV Repository** "git cloned" on September, 2016

ROADMAP

STEP 1 Downloaded last FDS REPO

STEP 2 Compiled FDS & made workable Coupling System

STEP 3 Run Simplify Test Case

NEXT STEPS (to be achieved)

STEP 4 Test more complex geometries

STEP 5 Compare the results obtained with those of the experimental tests

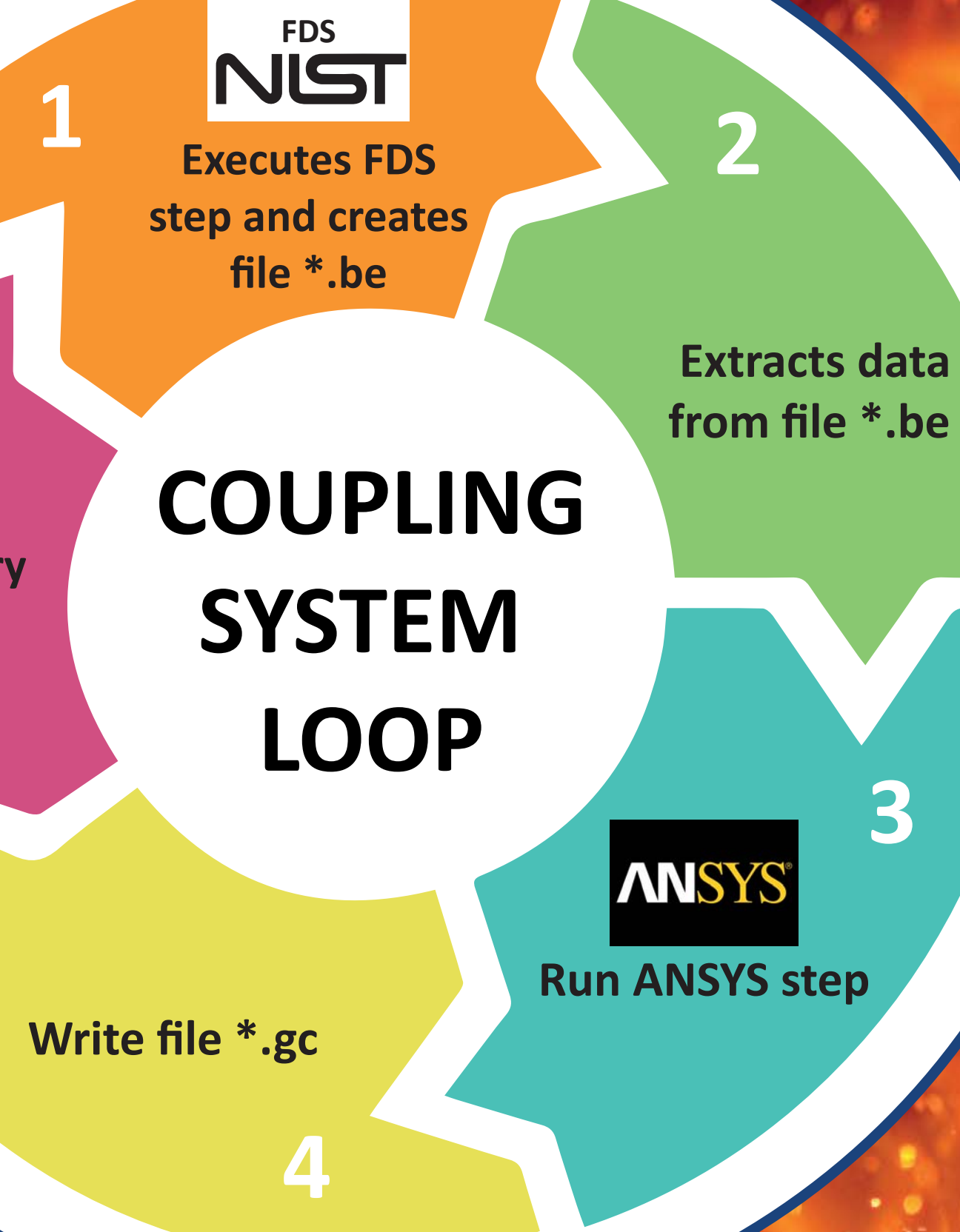**STEP 6** Use Coupling System in all interesting fields

TEST CASE - SUPPORTED PANEL

- The first step was to run the software with the available architecture, making it stable and working. This was achieved thanks to a careful analysis of the source files and a direct communication with developers.

- Once obtained a stable system, we created a test case: simply supported panel exposed to a localized fire.

- This example shows the TWOWAYCODE ability to translate the boundary conditions for a FEM model (ANSYS). The model is composed by a steel panel (2 x 0.3 x 0.0049 m) fully constrained to the ends.
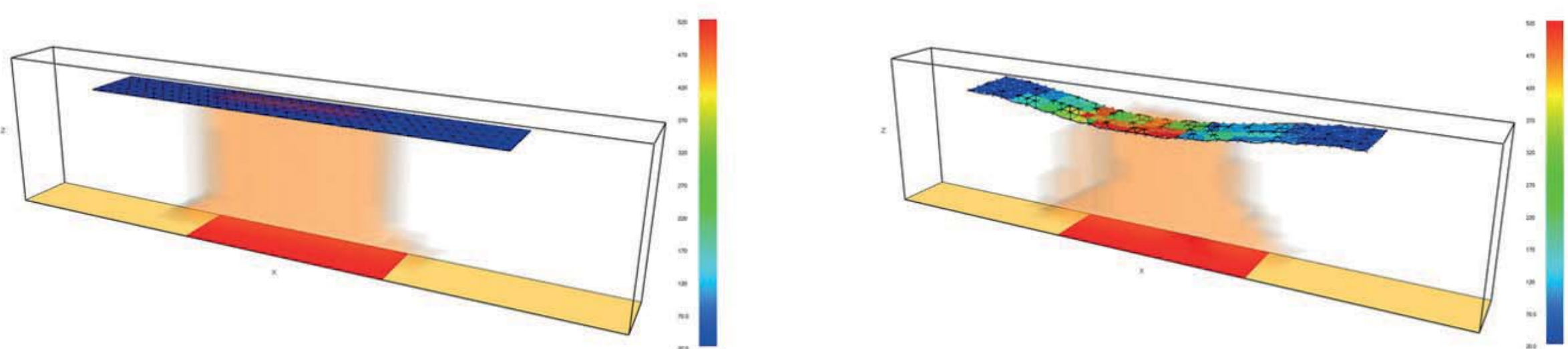
- The SMV images above presents the panel at the beginning and after 200[s] of fire test. (Smokeview (SMV) is a visualization program used to display the output of FDS)

- Results are under evaluation to understand if the obtained deformation is structural or depends exclusively on exposure to fire.

COUPLING SYSTEM LOOP

1. **FDS NIST** Executes FDS step and creates file *.be
2. Extracts data from file *.be
3. **ANSYS** Run ANSYS step
4. Write file *.gc
5. Refresh FDS geometry

CONCLUSION

The two-way approach can lead to a more accurate simulations.
Its advantages are related to cases where displacements can change the fire source or the fluid flow pattern, creating a different fire scenario.

In a two-way coupling strategy, the thermomechanical results, e.g., displacements, collapses, etc. are transposed back to the fire simulation.

Coupling system between Ansys and FDS may be used for fire-structure interaction, fire response and damage prediction of complex structures in a lot of application fields.

POTENTIAL APPLICATION FIELDS