Numerical simulation of industrial problems, application of ROM and HPC to large-scale studies

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Numerical simulations in the industrial environment are increasingly seeking to improve their realism by modeling larger problems with a finer description and by taking into account more parameters. It results in a significant increase in theirq "size" in terms of discretization scale, both spatially and temporally, and in the number of parameters to be taken into account. To address this issue, some industrial are working on advanced numerical methods to add them in a more or less intrusive way in their softwares developed internally. In recent years, two closely related axes have been developed to deal with these large studies.

In a first level, High Performance Computing (HPC) approach allows to reach extremely fine modeling levels. For example, in solid mechanics, we can achieve studies with 10^9 degrees of freedom, using 10^3 MPI processes on supercomputers. This type of modeling requires to recode or restart "from scratch" development of industrial softwares and to adapt the linear solvers for such large systems.

In a second level, Reduced Order Methods (ROM) with reduced basis as POD and PGD, etc., allow to build a reduced and cheap model from training data of a reference model (computed using HPC) and/or from experimental data. This type of approach is very efficient to treat problems with a large number of parameter sets. The adaptation of these methods for certain nonlinear problems such as problems in the form of variational inequalities are currently an important subject of work.

EDF R&D works on these two aspects with multiple industrial and academic collaborations. We propose to share during this presentation the latest advances integrated in the framework of *code_ aster* and to present some recent results.