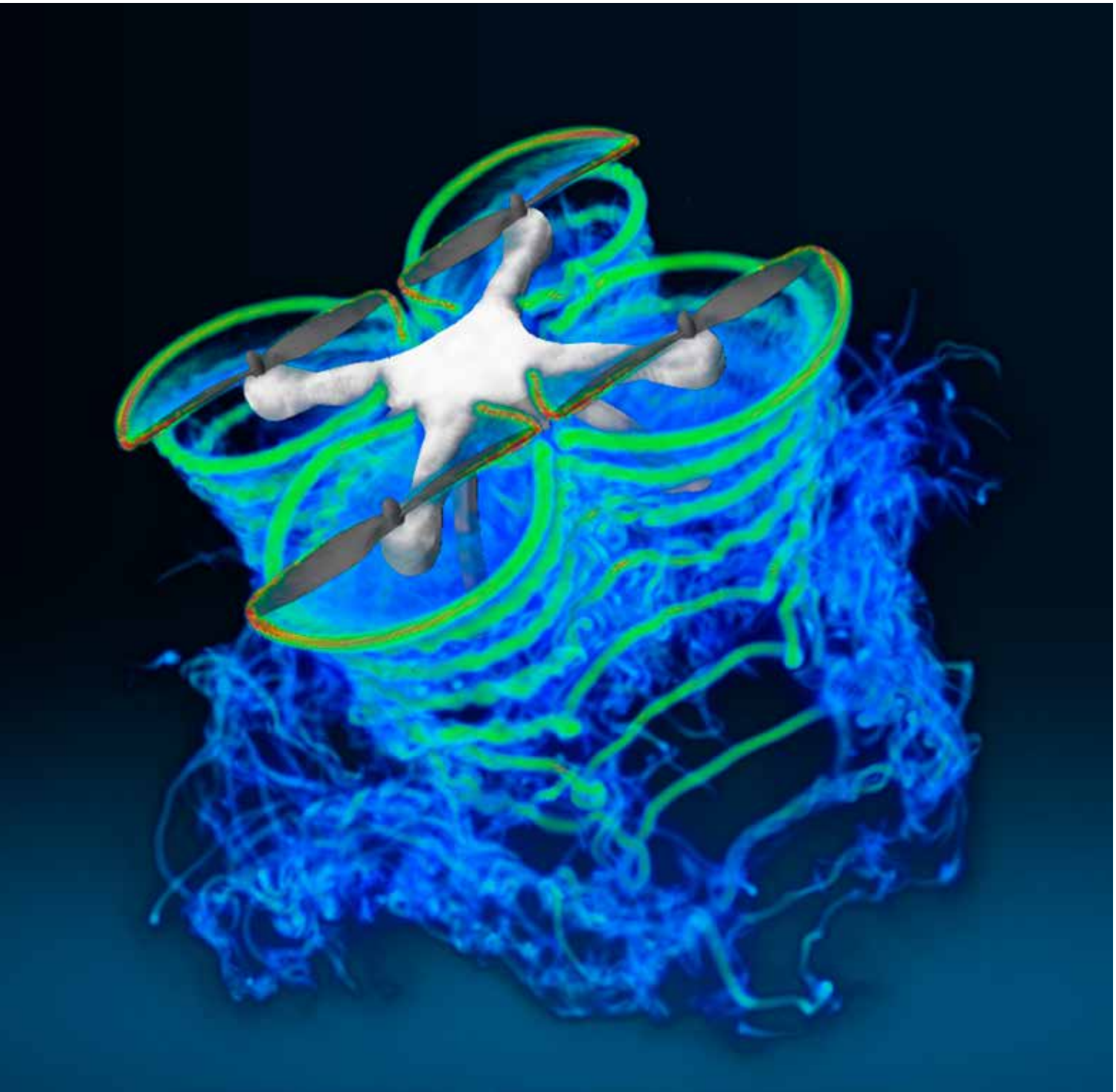
DASSAULT SYSTEMES

SIMULIA

3DEXPERIENCE®

XFlow

HIGH FIDELITY COMPUTATIONAL FLUID DYNAMICS



XFlow

OVERVIEW

In the traditional mesh-based approach to solving Computational Fluid Dynamics (CFD) problems, reliability is highly dependent on the quality of the mesh. Engineers spend most of their time working on the discretization of the mesh. Additionally, there are difficulties in dealing with the changes in the topology of the domain for problems involving the presence of moving parts or fluid-structure interaction.

With its automatic lattice generation and adaptive refinement, SIMULIA XFlow minimizes user inputs while reducing time and effort in the meshing and pre-processing phase of a typical CFD workflow. XFlow's Wall-Modeled Large Eddy Simulation (WMLES) method efficiently resolves the majority of turbulence scales providing high-resolution insight into complex flow physics.

XFlow offers particle-based Lattice-Boltzmann technology for high fidelity Computational Fluid Dynamics (CFD) applications expanding SIMULIA's CFD portfolio. XFlow's state-of-the-art technology enables users to address complex CFD workflows involving high frequency transient aerodynamics with real moving geometries, complex multiphase flows, free surface flows and fluid-structure interactions.

Advanced rendering capabilities of XFlow provide realistic visualization to gain deeper insight into flow and thermal performance, enabling users to make informed design decisions faster. XFlow is fully parallelized to leverage the power of High Performance Computing (HPC), accelerating the execution of realistic CFD simulations to reduce or replace physical testing.

UNIQUE CFD APPROACH

In non-equilibrium statistical mechanics, the Boltzmann equation describes the behavior of a gas modeled at mesoscopic scale. The Boltzmann equation is able to reproduce the hydrodynamic limit but can also model rarified media with applications to aerospace, microfluidics or even near vacuum conditions.

As opposed to standard Multiple Relaxation Time (MRT), the scattering operator in XFlow is implemented in central moment space, naturally improving the Galilean invariance, the accuracy and the stability of the code.

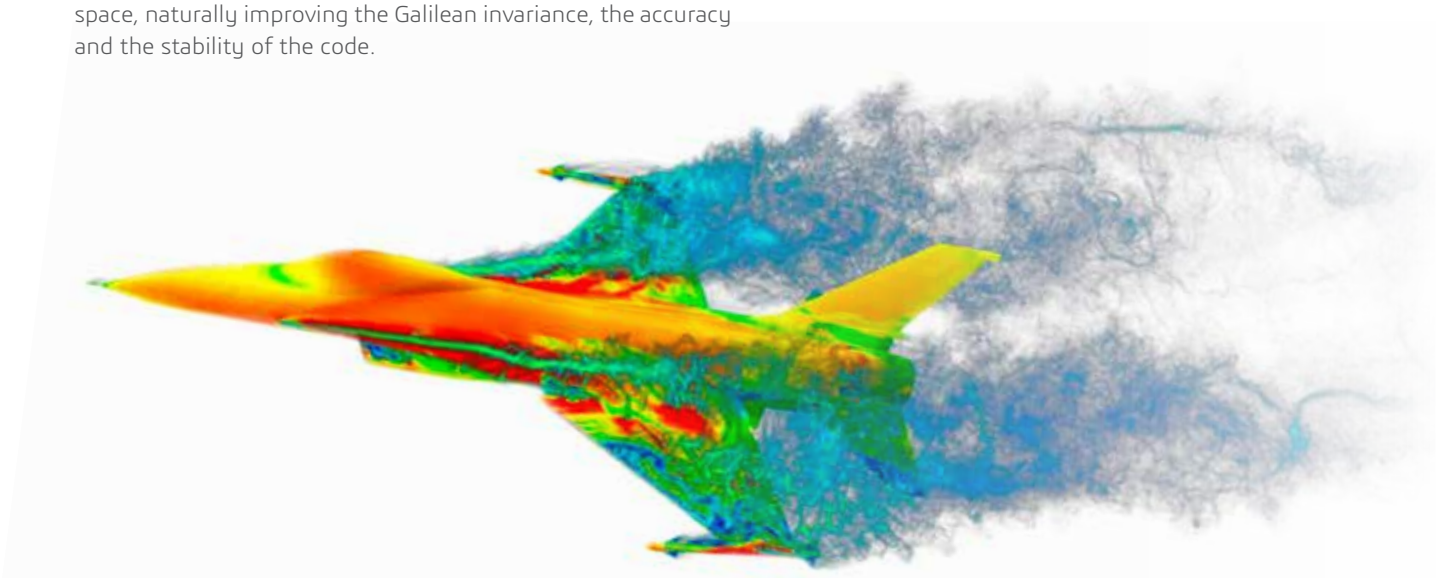
KEY CAPABILITIES

- Single Phase flow model
- Multiphase and Free-Surface flow models
- Acoustics analysis
- Thermal analysis
- Scalar transport
- Discrete Phase Model (DPM)
- Non-Newtonian flows
- Conjugated Heat Transfer
- Radiation
- Complex boundary conditions, including porous media and fan model
- Real moving parts

BOLTZMANN

NAVIER-STOKES

EULER



SOFTWARE ENVIRONMENT

Unified Pre-processor, Solver and Post-processor

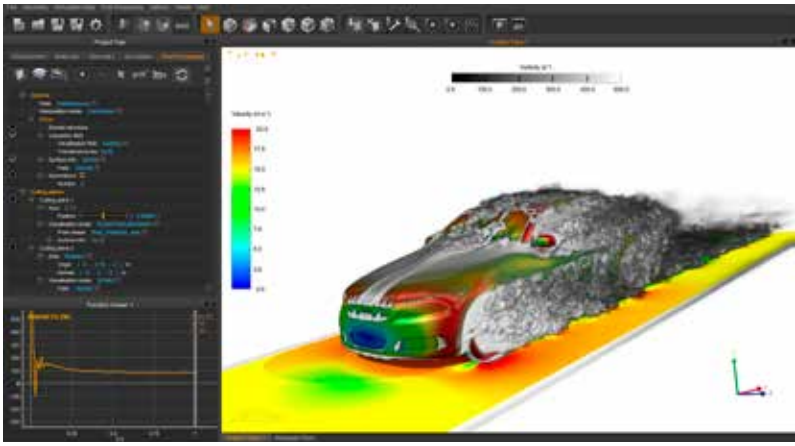
XFlow provides a unique and novel interface and working environment for the user. The pre-processor, solver and post-processor are fully integrated in the same environment. The User Interface layout is fully configurable with movable workspace windows and options to use pre-set display settings.

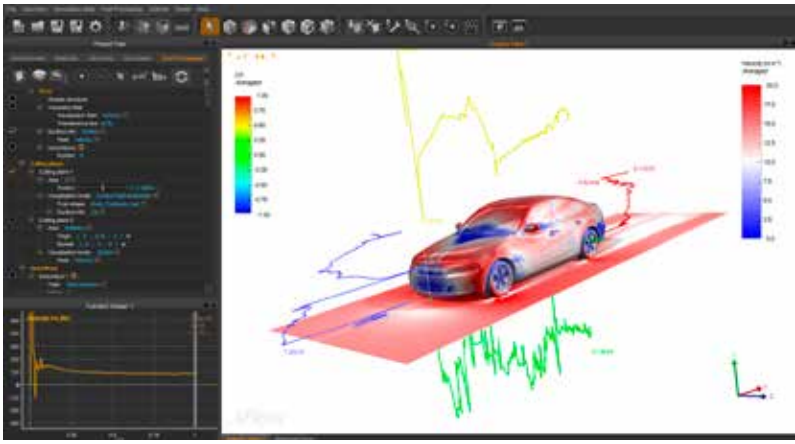
Pre-processing

Being particle-based, the algorithms behind XFlow lower the requirements imposed on the CAD models. For example, in the analysis of external aerodynamics, the software is not concerned with moving or crossing surfaces as soon as these define a coherent fluid volume. XFlow reduces the number of parameters the user has to set to define the flow characteristics and generate the fluid domain. Thus, the complexity of the geometry is not a limiting factor in XFlow.

Post-processing

The graphical post-processing capability of XFlow allows interactive visualization of the solution and allows numerical analysis even while the computation is still running. XFlow provides tools for additional processing through export to third-party applications such as ParaView and EnSight Gold.



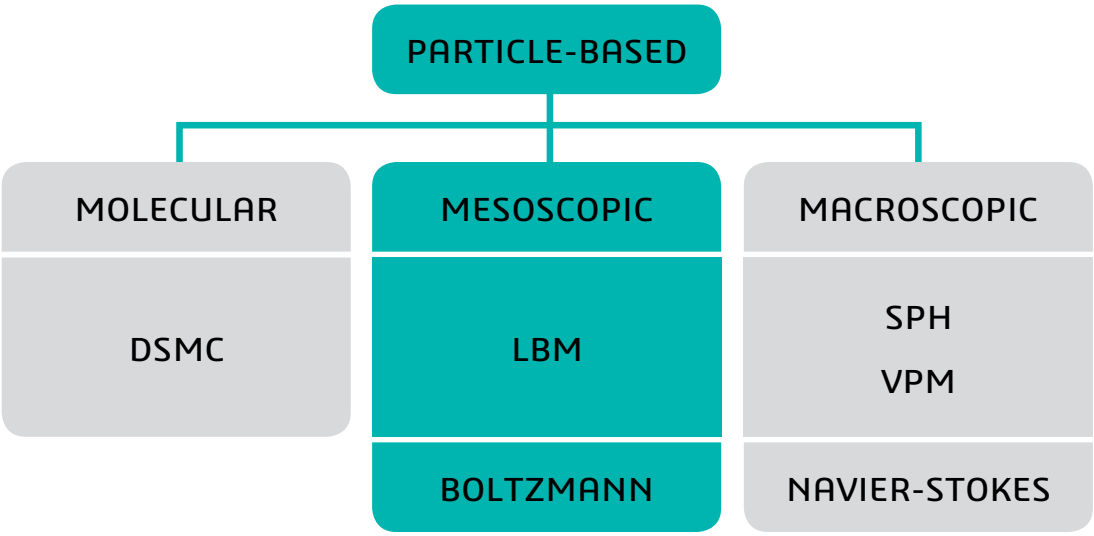


TECHNOLOGY

Particle-Based Kinetic Solver

XFlow features a novel particle-based kinetic algorithm that has been specifically designed to perform very fast with accessible hardware.

The discretization approach in XFlow avoids the classic domain meshing process and the surface complexity is not a limiting factor anymore. The user can easily control the level of detail of the underlying lattice with a small set of parameters, the lattice is tolerant to the quality of the input geometry, and adapts to the presence of moving parts.

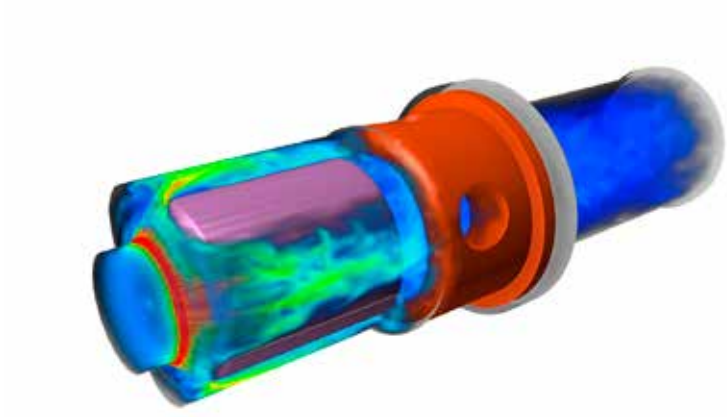


Adaptive Wake Refinement

XFlow automatically adapts the resolved scales to the user requirements, refining the quality of the solution near the walls, dynamically adapting to the presence of strong gradients and refining the wake as the flow develops.

Single Consistent Wall Model

XFlow uses a non-equilibrium wall function to model the boundary layer. This wall model takes into account the adverse pressure gradients responsible for flow separation, important in aerodynamics analysis. Moreover, the wall model is automatically disabled as soon as the lattice size near walls is small enough to resolve directly the flow in the boundary layer.



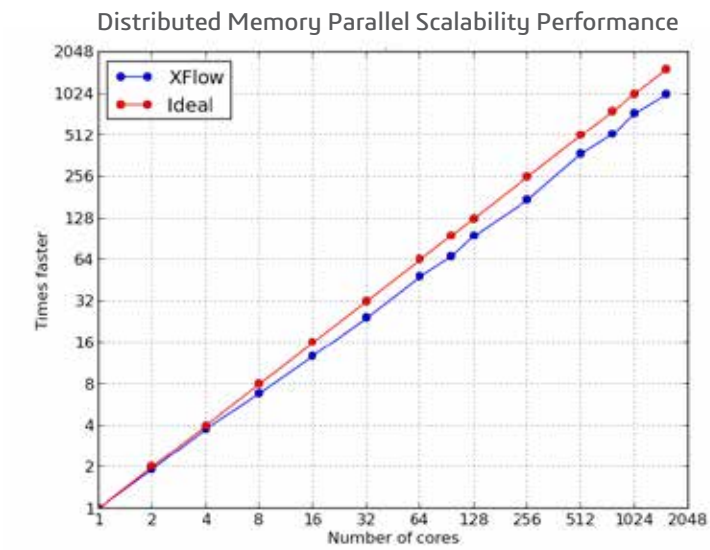
NEAR-LINEAR SCALABLE PERFORMANCE

Shared Memory Parallel (SMP) Performance

XFlow is fast, efficient and accessible even on a standard desktop PC. XFlow is fully parallelized for multi-core technology with near-linear scalability.

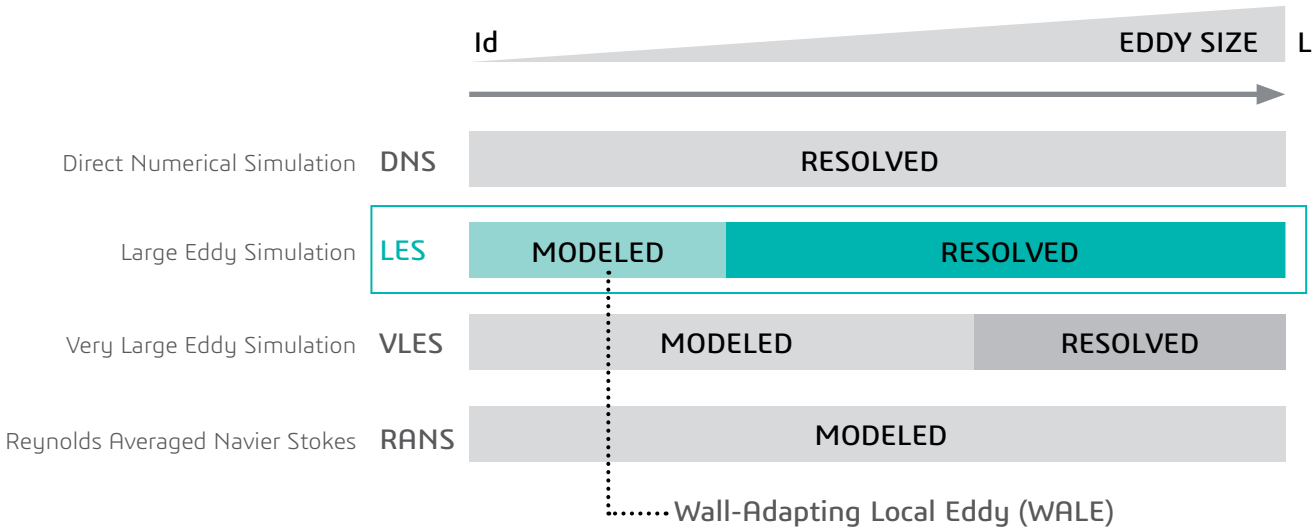
Distributed Memory Parallel (DMP) Performance

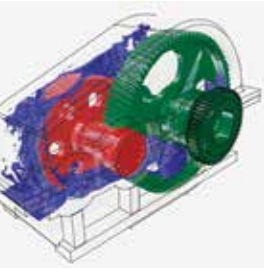
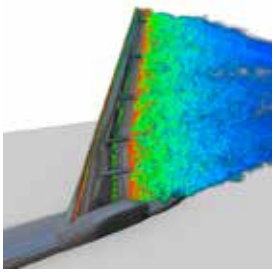
XFlow also perfectly integrates into your HPC environment, which opens a wide range of possibilities for the most demanding computations. XFlow's distributed solver scales efficiently even for a large number of nodes.

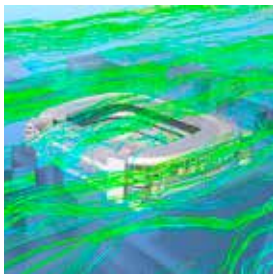
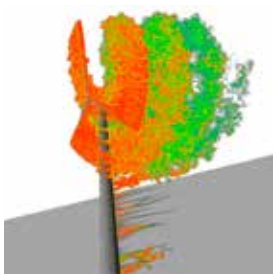


TURBULENCE MODELING: HIGH FIDELITY WMLES

XFlow features a high fidelity Wall-Modeled Large Eddy Simulation (WMLES) approach to turbulence modeling. The underlying state-of-the-art LES, based on the Wall-Adapting Local Eddy (WALE) viscosity model, provides a consistent local eddy-viscosity and near wall behavior.




INDUSTRY APPLICATIONS

Transportation & Mobility

- Moving geometries such as rotating wheels, suspension system, or vehicle overtaking
- Powertrain lubrications
- Refueling and tank sloshing
- Wading and painting process

Aerospace & Defense

- Flight maneuvers prediction
- Helicopters and turbofans
- Drag and lift prediction even for high lift configurations
- Pressure and skin friction loads distribution
- Moving parts such as deployment of the landing gear, varying flaps configuration, or rotary wings
- Transonic / supersonic flows

Marine & Offshore

- Ship hulls hydrodynamics
- Sailing maneuvers
- Sloshing phenomena
- Wave propagation

Architecture, Engineering & Construction

- Airflow around buildings, bridges and other civil engineering works
- Free surface analysis of marine structures, dam spillways or flooding of underground facilities
- Heating, air-conditioning and ventilation of indoor spaces
- Dispersion of contaminants

Energy, Process & Utilities

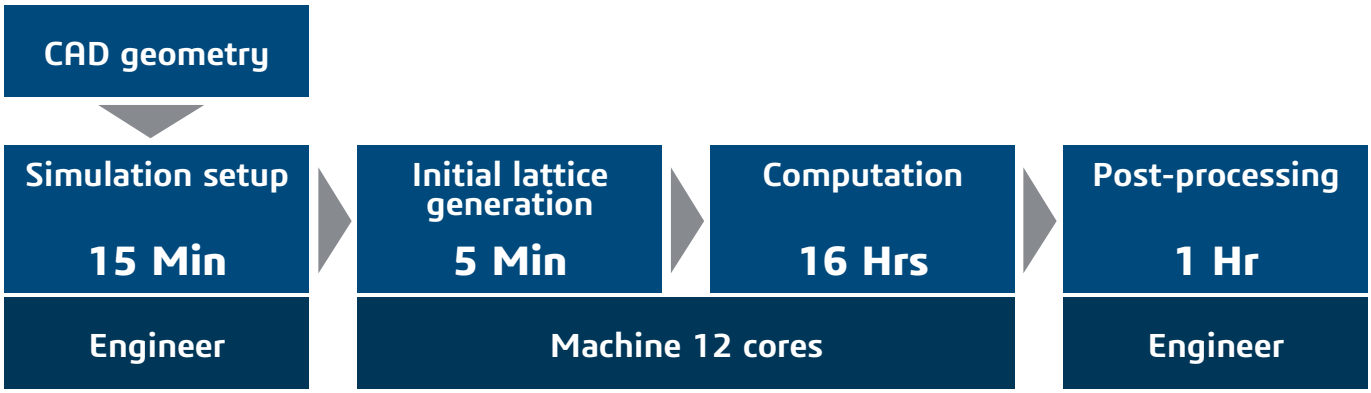
- Wind turbines (Onshore/Offshore) and drivetrain
- Oil & Gas flows
- Analysis of water wheels and waves energy convertors
- Natural convection in solar towers
- Wind loads on solar panels

Industrial Equipment

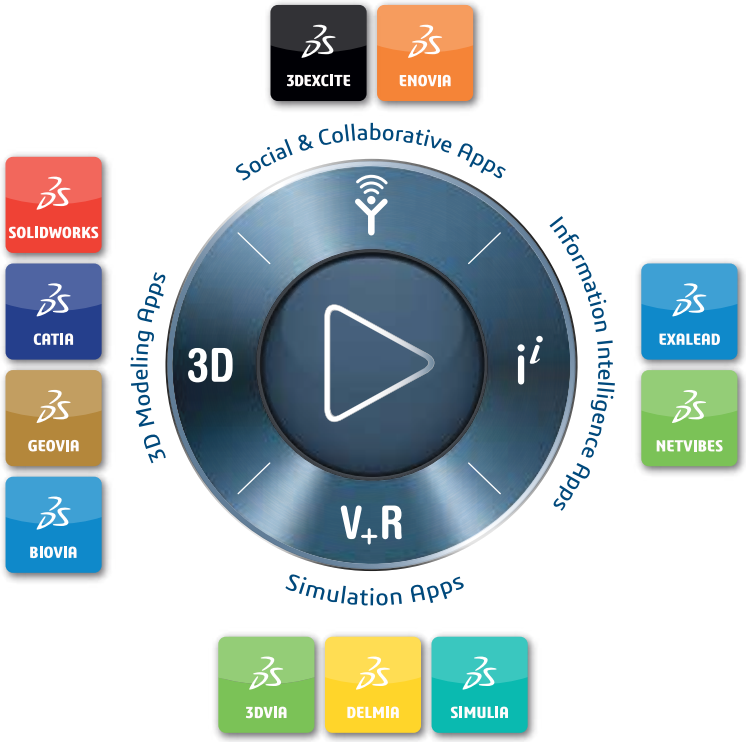
- Internal moving parts simulations such as valves and pumps
- Simulation of mixing processes (agitators, mixers)
- Thermal management in data centers
- Fluids with complex rheological properties (non-Newtonian viscosity models)

PROCESS TIME: WORKFLOW EXAMPLE

XFlow drastically cuts the time spent on the preparation of the simulation, and the initial domain discretization. It enables you to optimize the balance of your engineering and computer time costs.



Based on High-fidelity Transient CFD Simulation conducted for the AIAA 1st High Lift Prediction Workshop



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