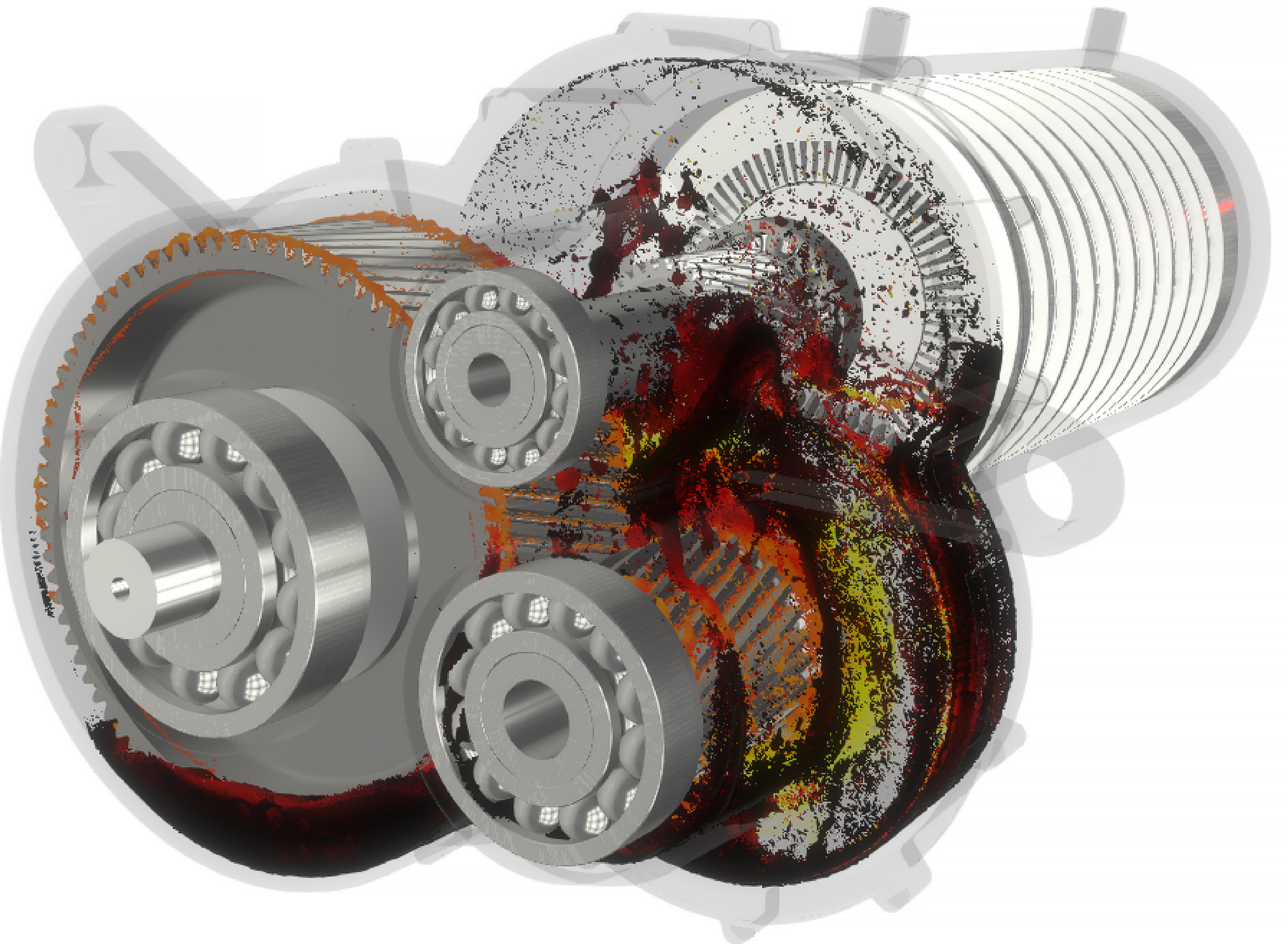
XFlow
FLUIDS SIMULATIONS TO IMPROVE REAL-WORLD PERFORMANCE



XFlow

OVERVIEW

In the modern competitive world of product innovation, industries demand the complex simulation of their product's real-world behavior under extreme conditions; such as vehicles wading, powertrain lubrication and critical flight maneuvers, XFlow offers particle-based Lattice-Boltzmann technology for high fidelity Computational Fluid Dynamics (CFD) applications as a part of SIMULIA's Fluids Simulation portfolio. The state-of-the-art technology of XFlow enables users to address complex CFD workflows involving high frequency transient simulations with real moving geometries, complex multiphase flows, free surface flows and fluid-structure interactions.

Its automatic lattice generation and adaptive refinement capabilities minimize user inputs thereby reducing time and effort in the meshing and pre-processing phase. This enables engineers to focus the majority of their efforts on design iteration and optimization.

With XFlow's discretization approach, surface complexity is also not a limiting factor. The underlying lattice can be controlled 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.

Advanced rendering capabilities provide realistic visualization to gain deeper insight into flow and thermal performance. XFlow's unique capabilities enable companies to reduce physical testing while making to make better design decisions faster.

SIMULIA Fluids Simulation is driven by three complimentary technologies that provide customers with scalable fluids simulation to address broad range of real world applications. Dassault Systèmes SIMULIA brand is committed to enhancing and expanding our Fluids Simulation portfolio to provide end-to-end solutions for broad range of Industry Processes on the **3D**EXPERIENCE® platform.

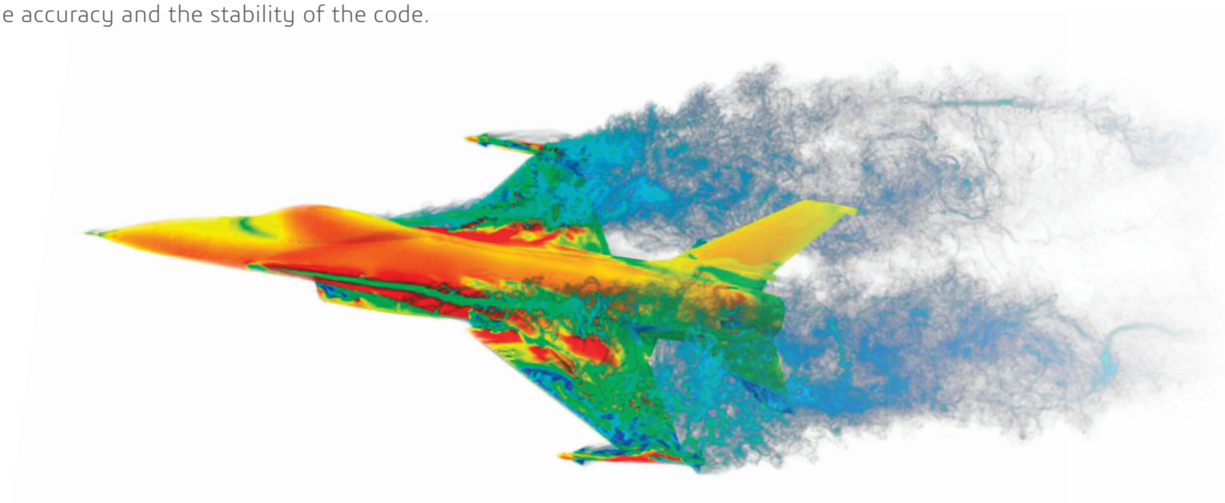
UNIQUE CFD APPROACH

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
- Free-surface flow model
- Multiphase flow models: Particle-based tracking, Phase Field and VoF
- Acoustics analysis
- Thermal analysis
- Conjugate Heat Transfer (CHT) boundary condition
- Radiation Montecarlo model
- Scalar transport
- Discrete Phase Model (DPM)
- Non-Newtonian flows
- Advance boundary conditions, including porous media and fan model
- Moving parts with enforced behavior
- Moving parts with rigid body dynamics up to 6 degrees of freedom
- Fluid-Structure Interaction (FSI) with Abaqus, Simpack and FMU
- Vibroacoustics analysis with Wave6
- Available on the **3D**EXPERIENCE platform through Power'By approach using the XFlow Specialist role



SOFTWARE ENVIRONMENT

Unified Pre-processor, Solver and Post-processor

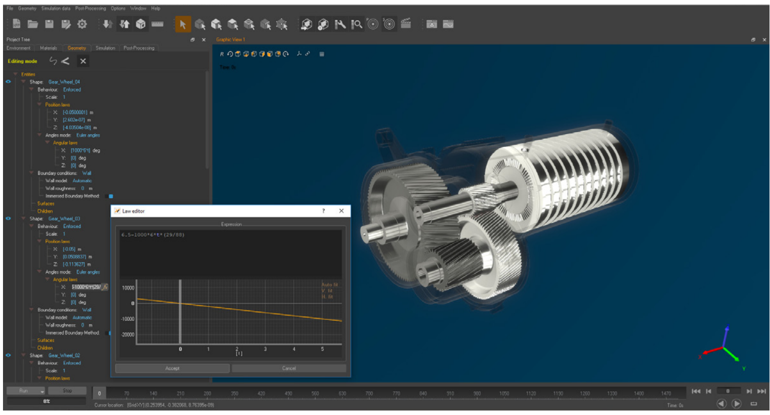
XFlow provides a unique and novel interface and working environment for the user. The pre-processor, solver and post-processor are fully integrated in the same environment. The User Interface layout is fully configurable with movable workspace windows and options to use pre-set display settings.

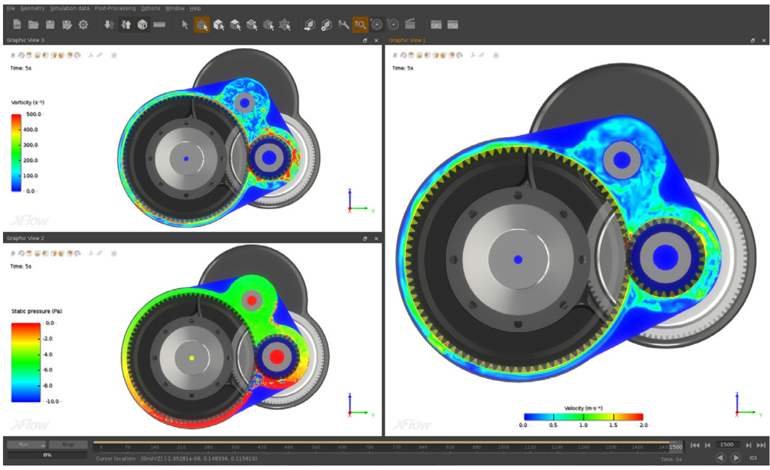
Pre-processing

Being particle-based, the algorithms behind XFlow lower the requirements imposed on the CAD models. For example, in the analysis of powertrain lubrication, 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 **3D**EXPERIENCE platform or third-party applications such as ParaView and EnSight Gold.



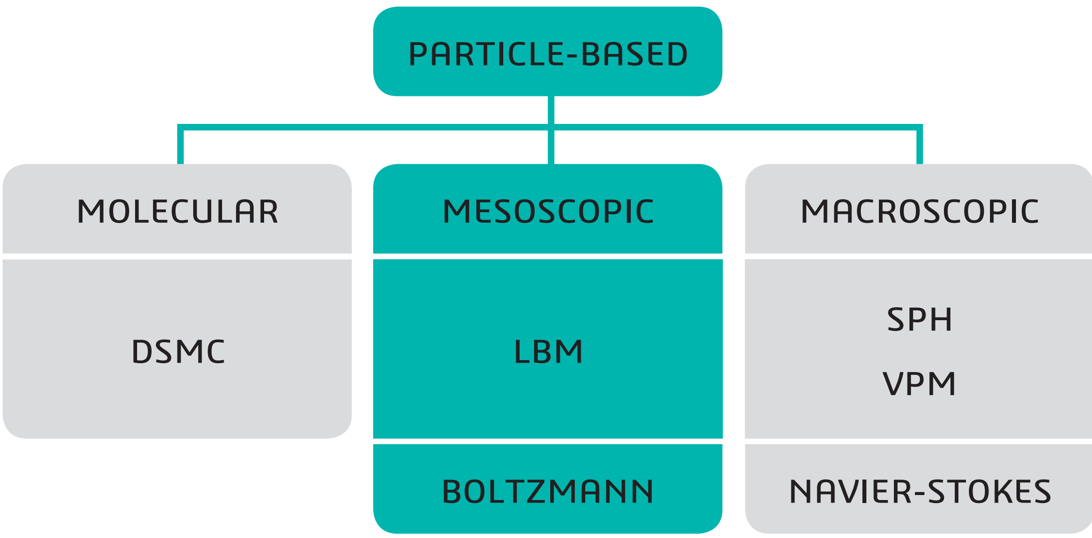


TECHNOLOGY

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.

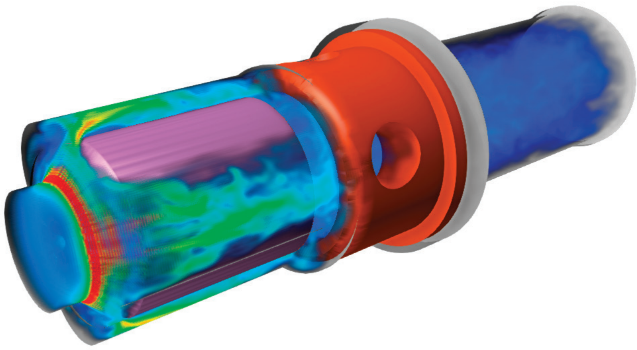


Adaptive Wake Refinement

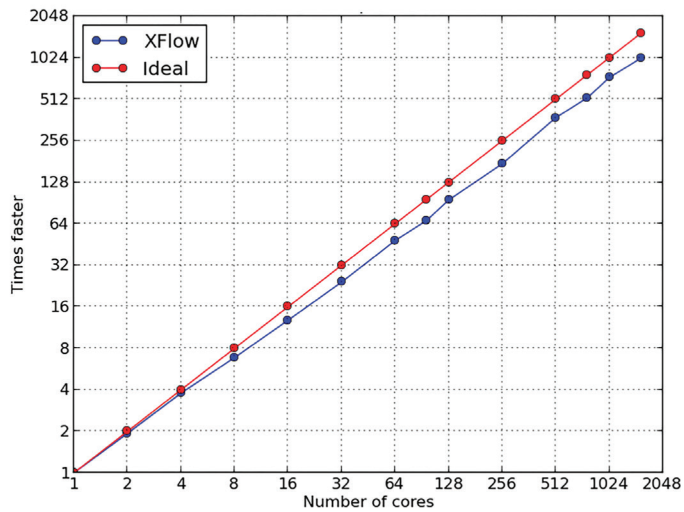
XFlow automatically adapts the resolved scales to the user requirements, refining the quality of the solution near the walls, dynamically adapting to the presence of strong gradients and refining the wake as the flow develops.

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.



Distributed Memory Parallel Scalability Performance



NEAR-LINEAR SCALABLE PERFORMANCE

Shared Memory Parallel (SMP) Performance

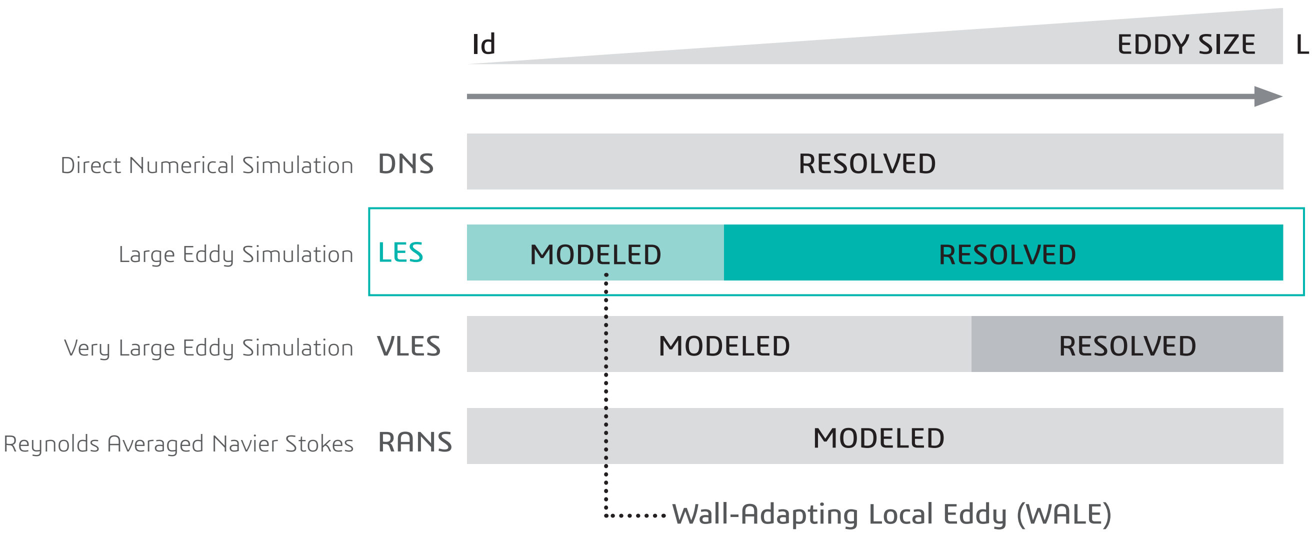
XFlow is fast, efficient and accessible even on a standard desktop PC. XFlow is fully parallelized for multi-core technology with near-linear scalability.

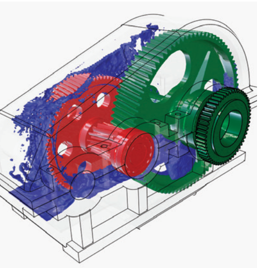
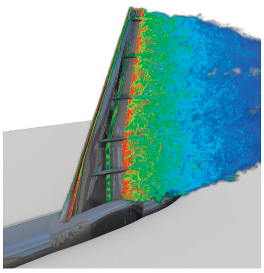
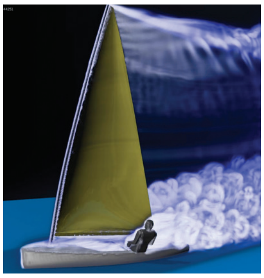
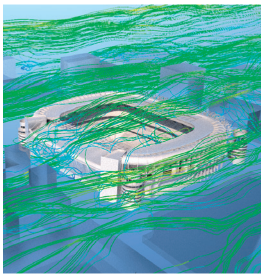
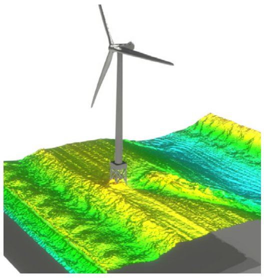
Distributed Memory Parallel (DMP) Performance

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 lubrication
- 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)

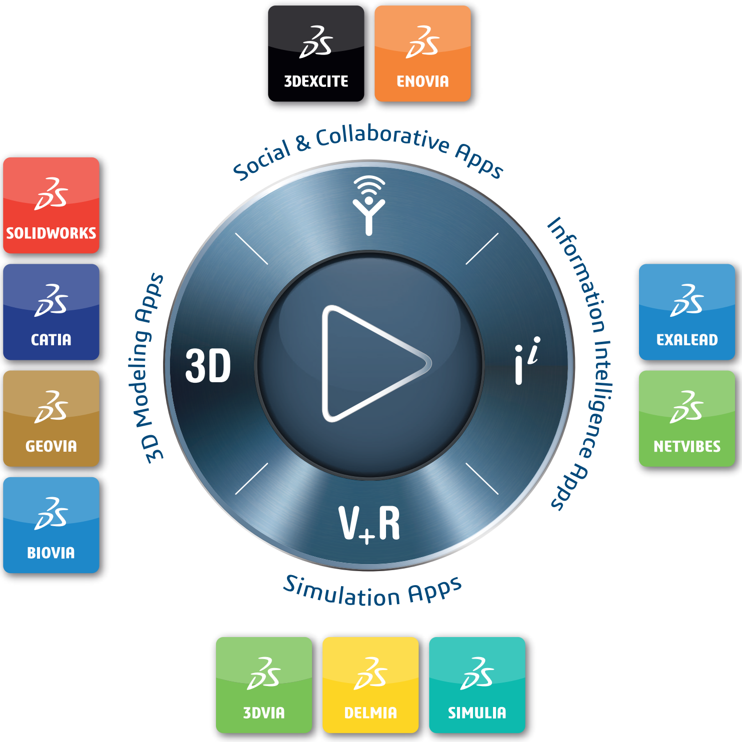
PROCESS TIME: WORKFLOW EXAMPLE

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.

CAD geometry

Simulation setup	Initial lattice generation	Computation	Post-processing
15 Min	5 Min	16 Hrs	1 Hr
Engineer	Machine 12 cores		Engineer

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



Our **3D**EXPERIENCE® platform powers our brand applications, serving 12 industries, and provides a rich portfolio of industry solution experiences.

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