Realize Your Product Promise®

ANSYS®

Why Supercomputing Partnerships Matter for CFD Simulations

Wim Slagter, PhD

Director, HPC & Cloud Alliances

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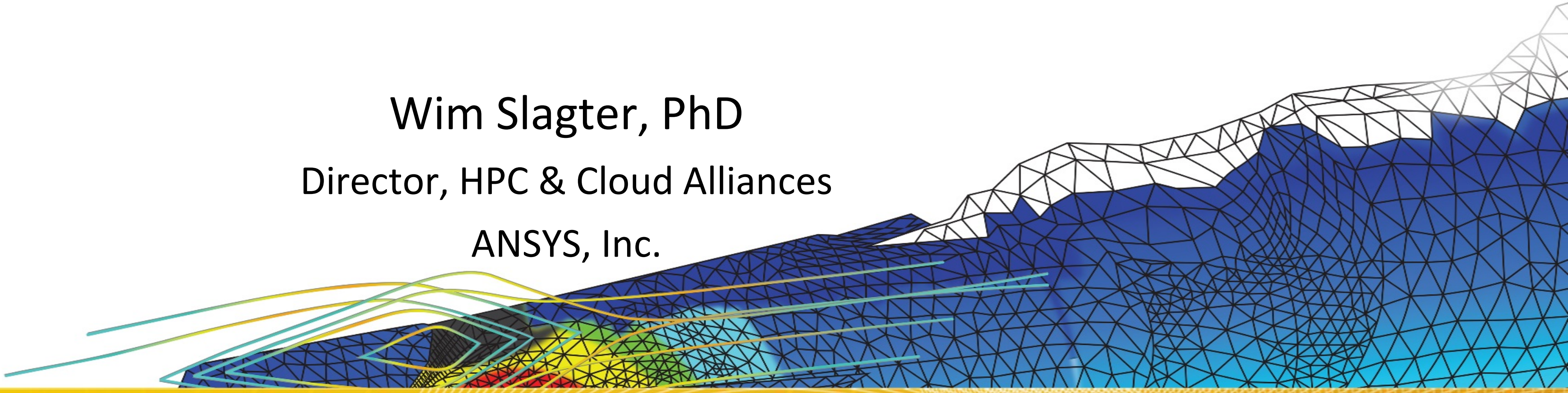
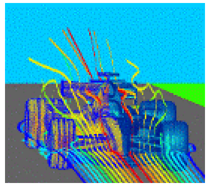


ANSYS is…



Fluids

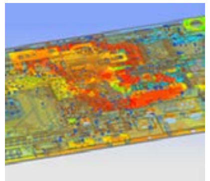
FOCUSED

This is all we do.
Leading product technologies in all physics areas
Largest development team focused on simulation

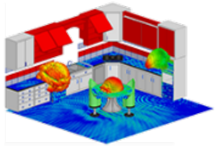
TRUSTED

96 of the top 100

FORTUNE 500 Industrials
ISO 9001 and NQA-1 certified



Power Integrity



Electromagnetics

CAPABLE

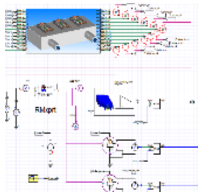
2,700+ employees

75 locations

40 countries

PROVEN

Recognized as one of the world's **MOST INNOVATIVE AND FASTEST-GROWING COMPANIES***

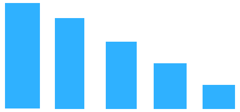


Systems

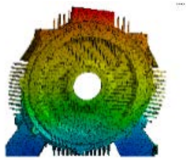
INDEPENDENT

Long-term financial stability
CAD agnostic

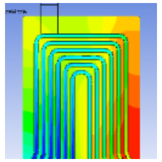
LARGEST



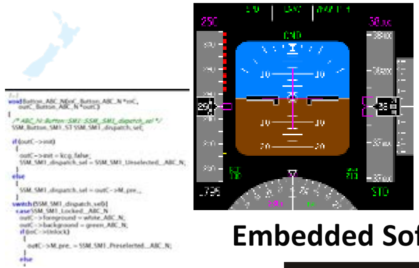
3x The size of our nearest competitor



Structures



Thermal



Embedded Software

**BusinessWeek, FORTUNE*

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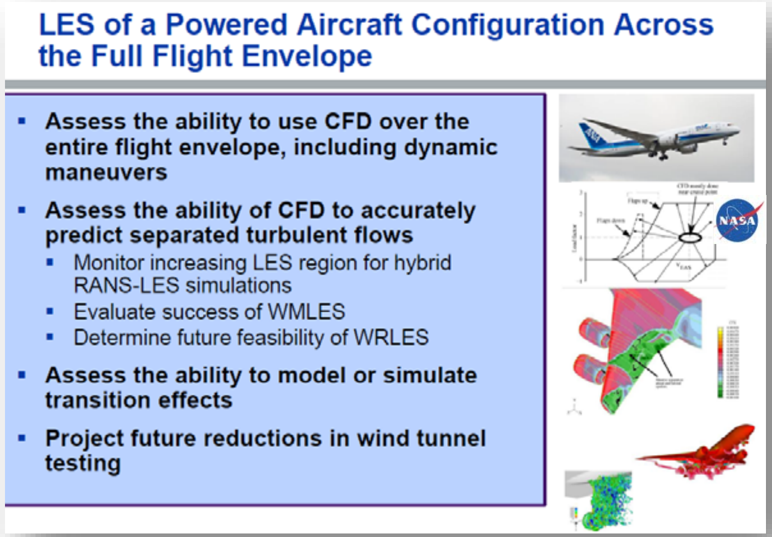
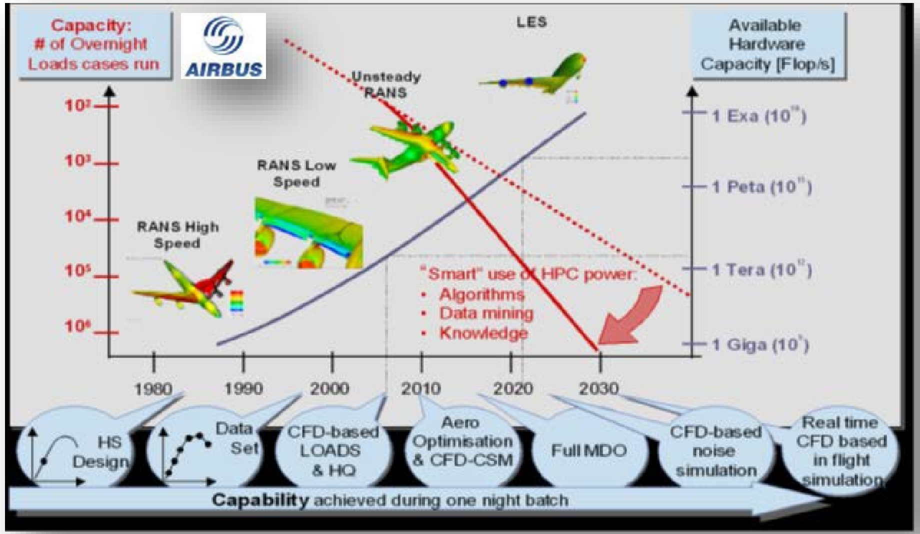
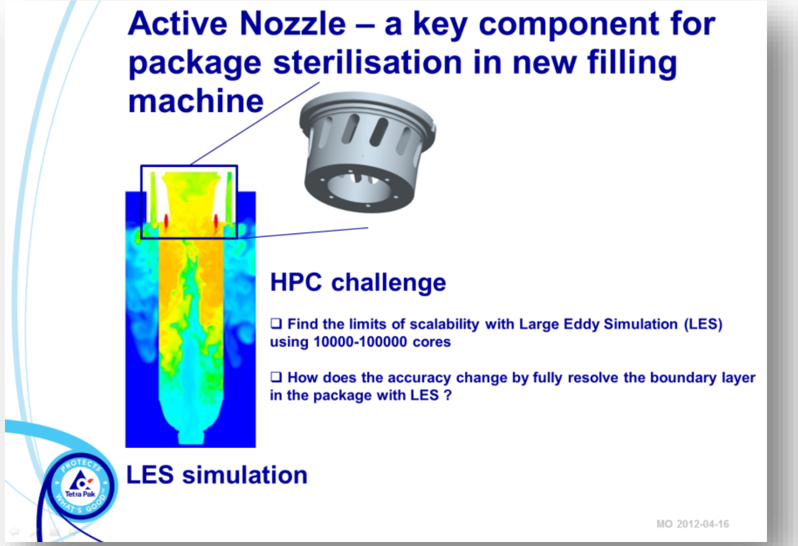
HPC Challenges in the Industry

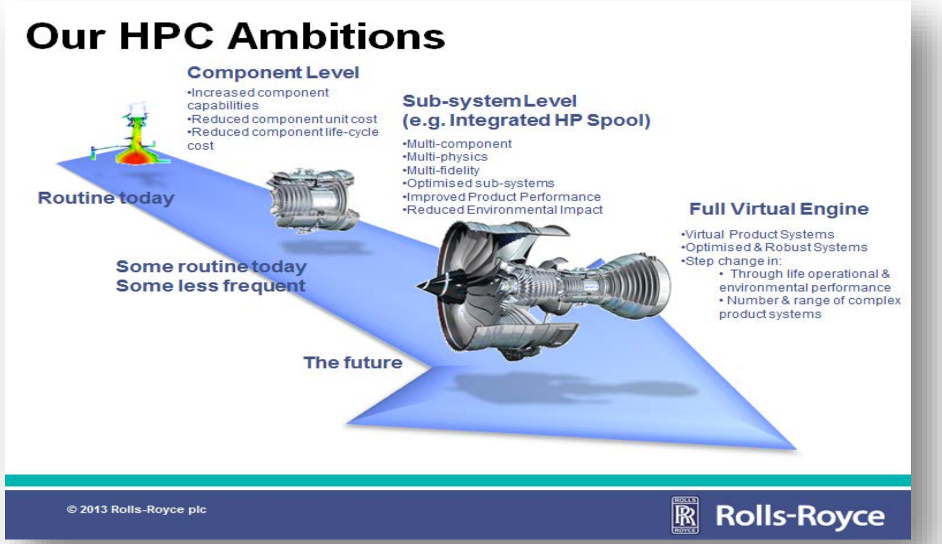


Source: "NASA Vision 2030 CFD Code – Final Technical Review", Contract # NNL08AA16B, November 14, 2013, NASA Langley Research Center



Source: "Exascale Challenges of European Academic & Industrial Applications", S. Requena, ISC'14, 22-26 June 2014, Leipzig



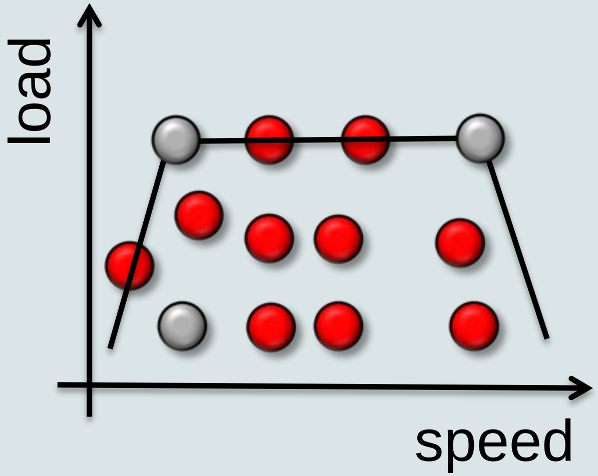


Source: "Computational Science and Engineering Grand Challenges in Rolls-Royce", Leigh Lapworth, Networkshop42, 1-3 April 2014, University of Leeds

HPC Demanding Simulations

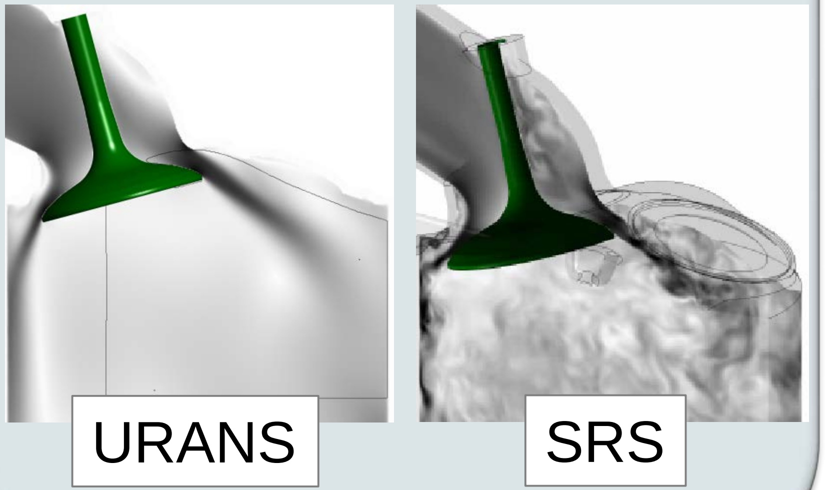
- Example of Gasoline Engine CFD

Need for More Operating Conditions



Today
Additional

Need to Increase Resolution (grid + physics)



Require New Levels of CFD Scalability and Performance

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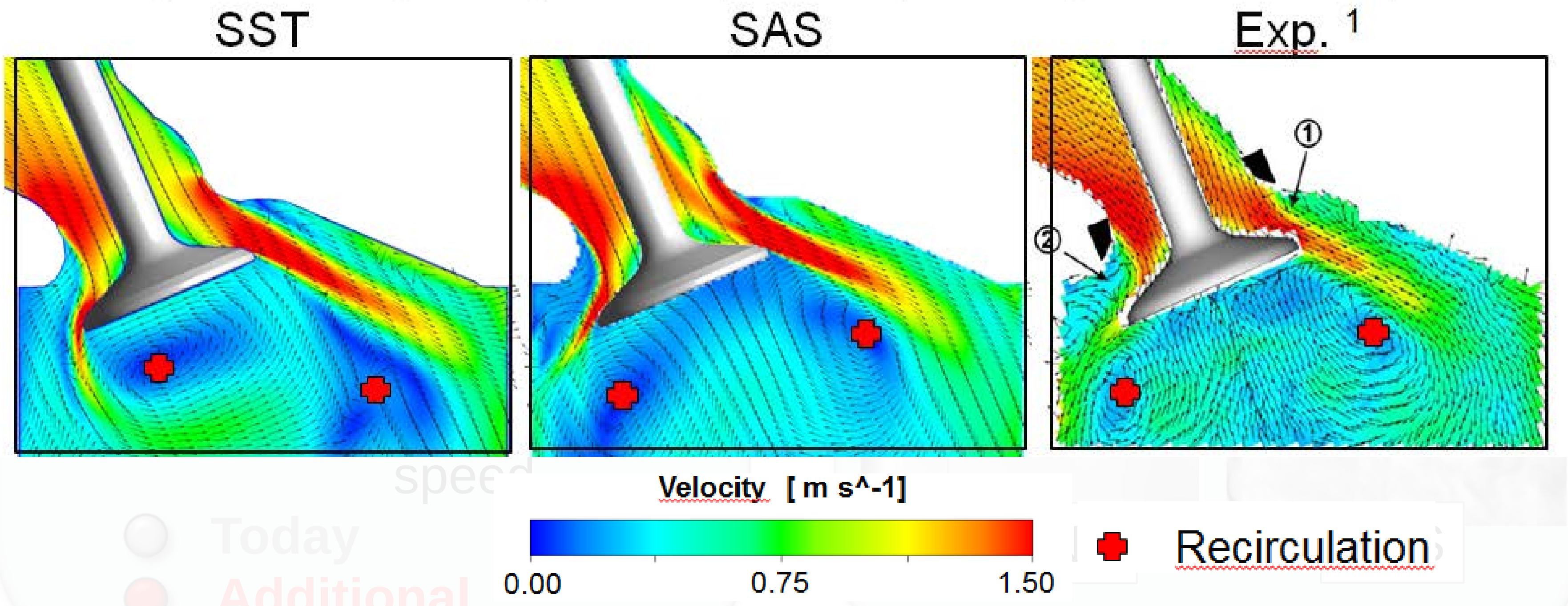
HPC Demanding Simulations

- Example of Gasoline Engine CFD

Need for More Operating

Need to Increase Resolution



Today

Additional

Require New Levels of CFD Scalability and Performance

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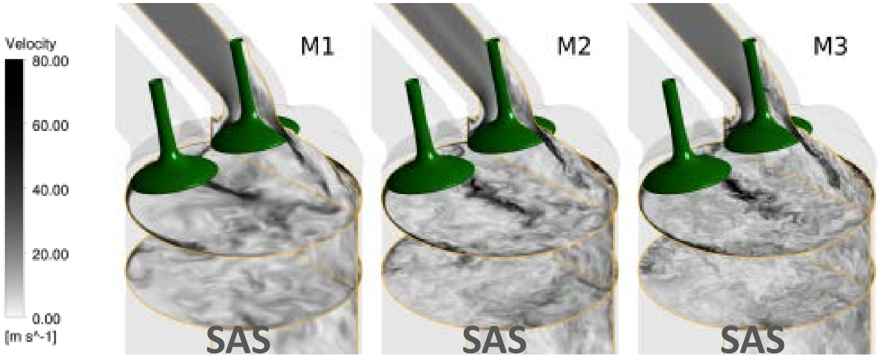
HPC Demanding Simulations

- Example of Gasoline Engine CFD

CFD model size [number of cells]	Compute requirement* [number of cores]
15 million	512
74 million	4096
280 million	35,000 (~1 petaflop)
493 million	61,440



*) This is an estimate of the Cray XC40 compute requirements with 2.5 GHz processors to run this gasoline engine CFD model in a production design environment (i.e. overnight turn around of 16 hrs.)

Require peta-scale performance for high-fidelity CFD

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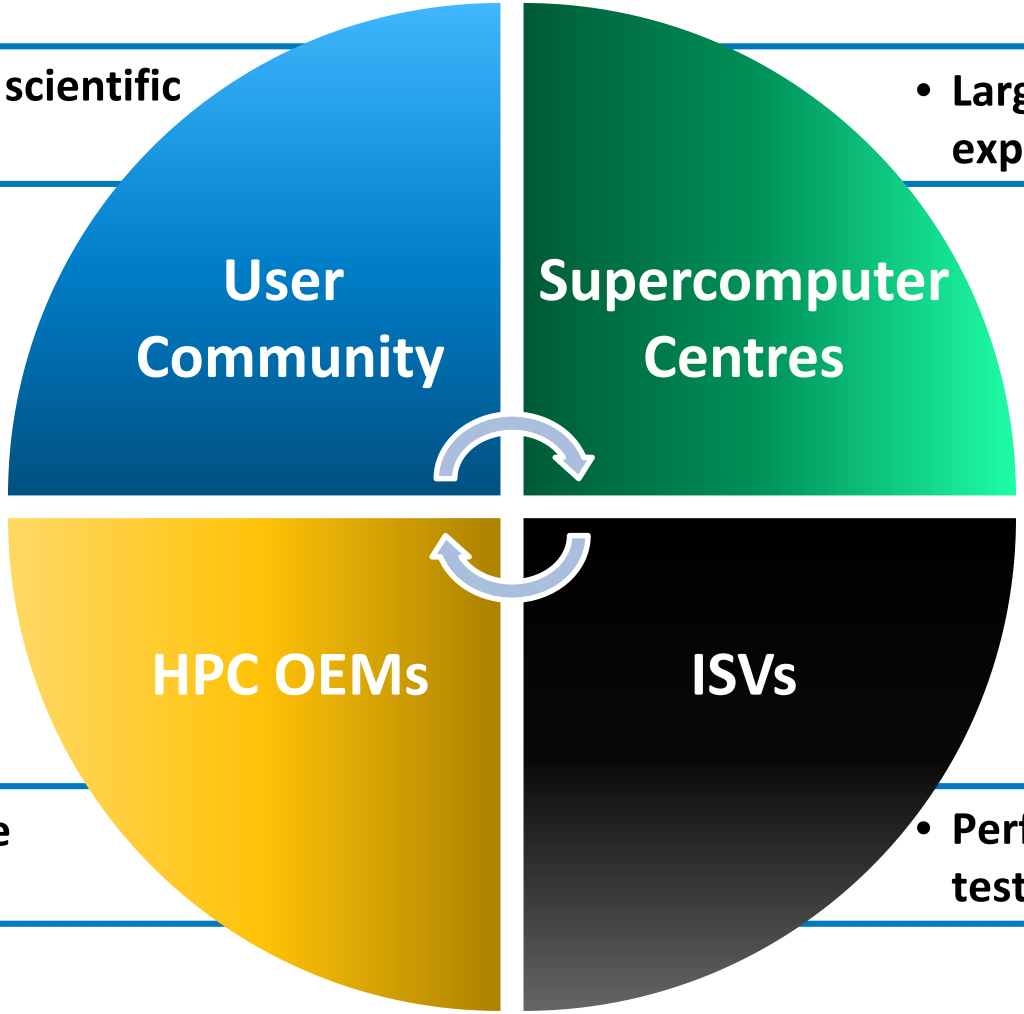
Partnerships are Crucial for Reaching New Supercomputing Heights

- Real-world, industrial or scientific applications

- Large HPC resources and system expertise

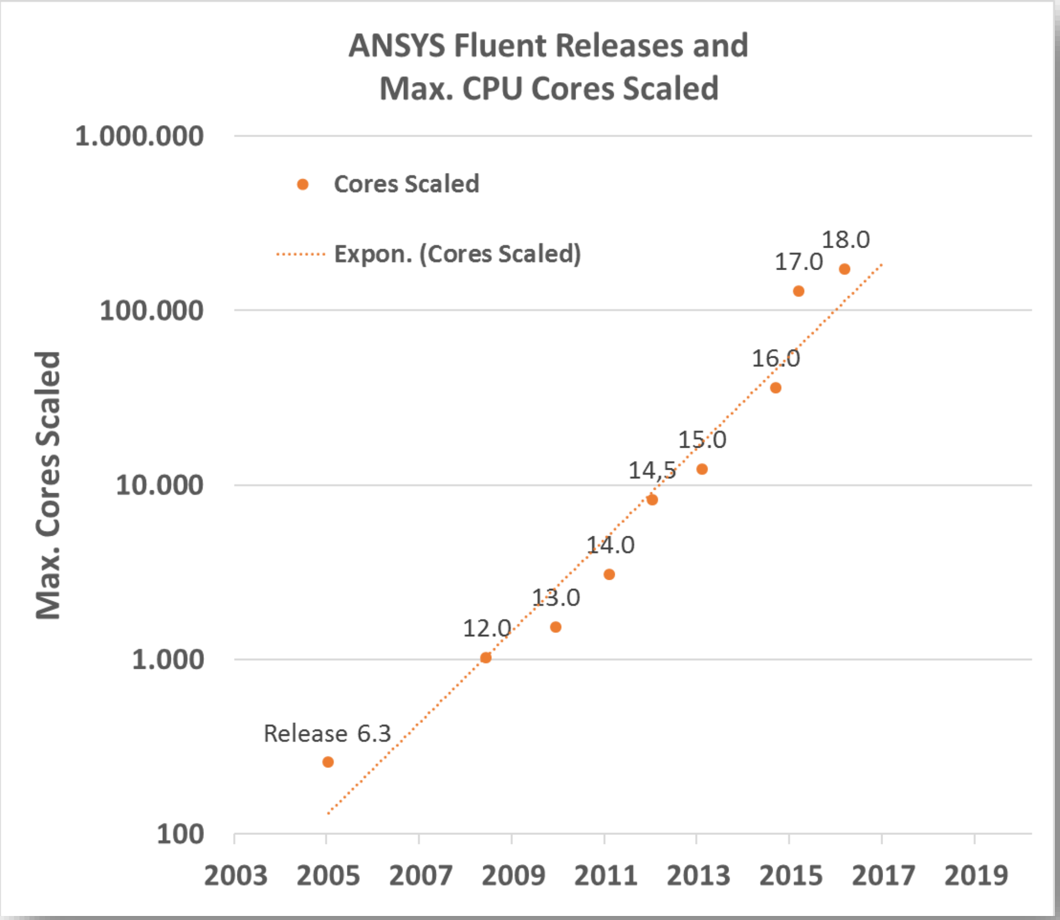


- Latest HPC infrastructure technologies

- Performance and scalability testing of SW

Software Scalability – Limiting Factor?!

"Software scalability is the most significant limiting factor in achieving the next 10x improvements in performance, and it remains one of the most significant factors in reaching 1,000x."



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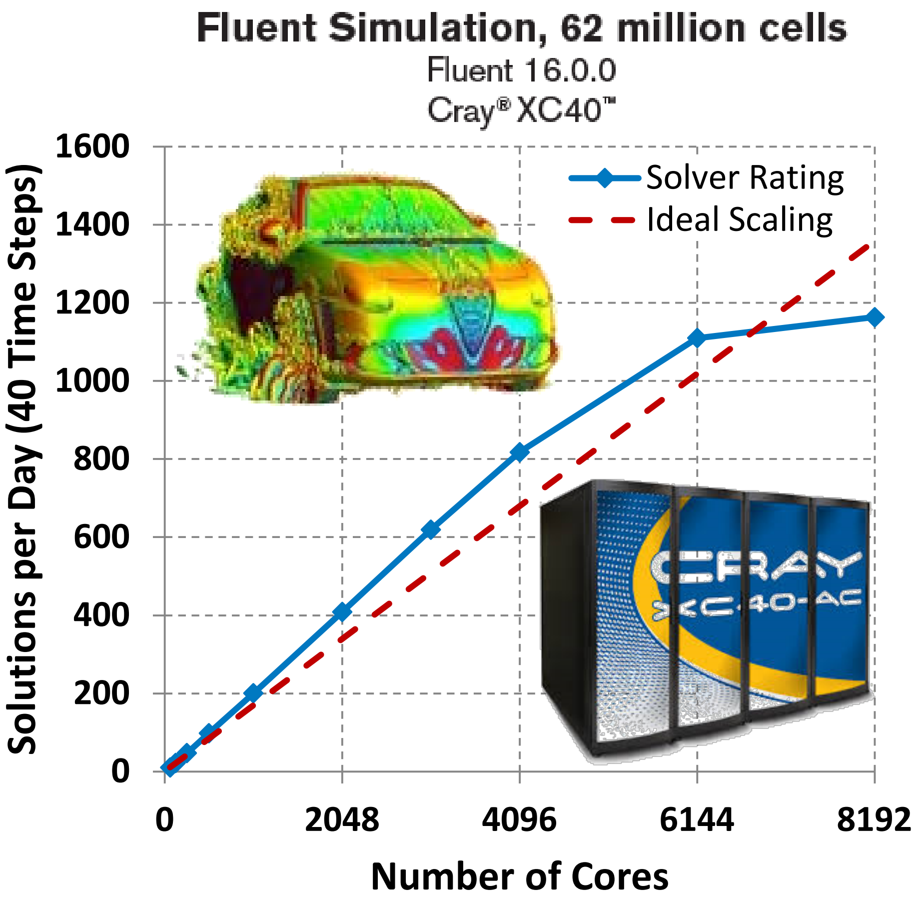
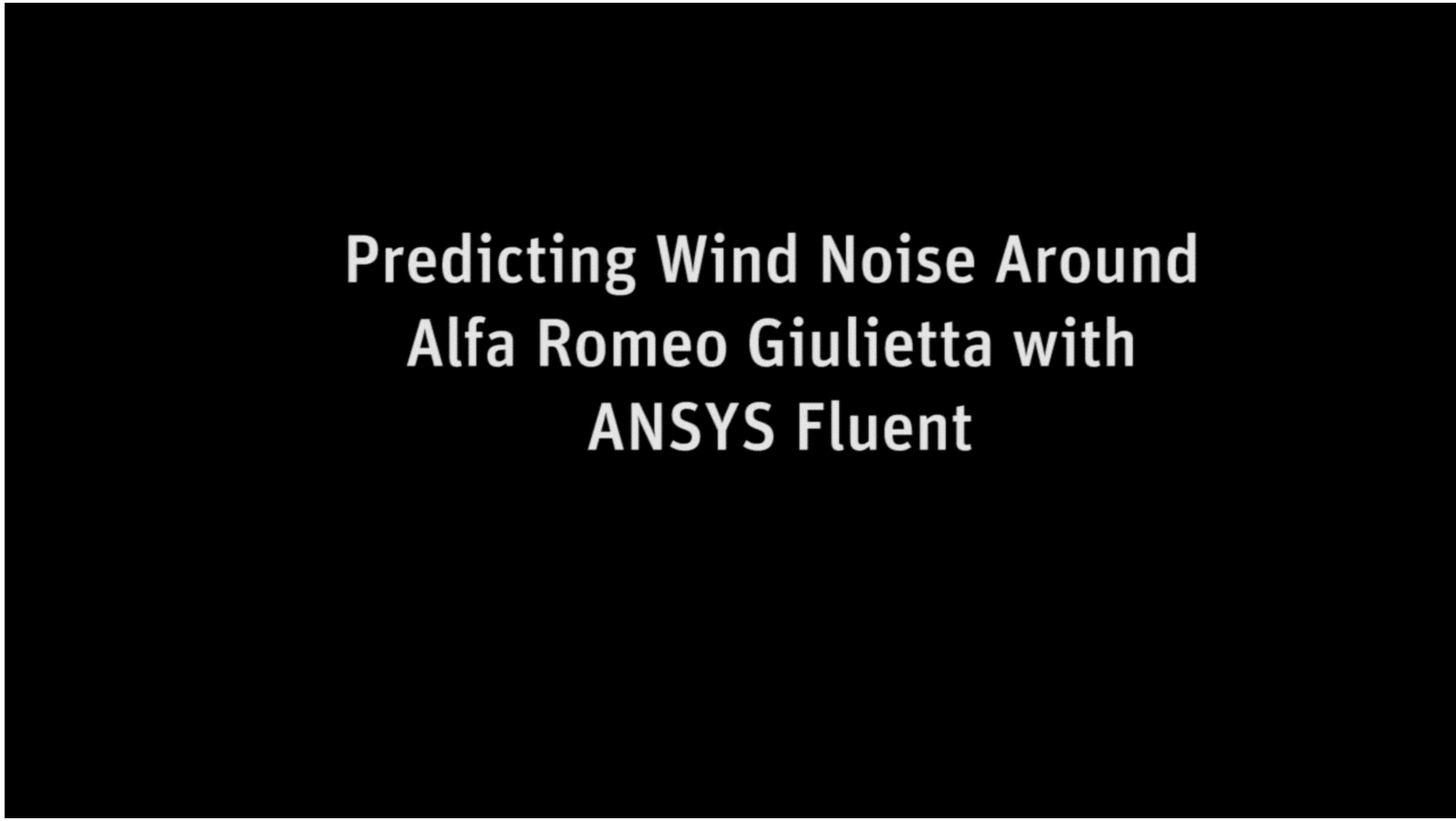
Source: Solve. Report by US Council on Competitiveness and Intersect360 Research, Oct 2014.

Software Scalability – Example

- Improvements Through Partnership with Cray





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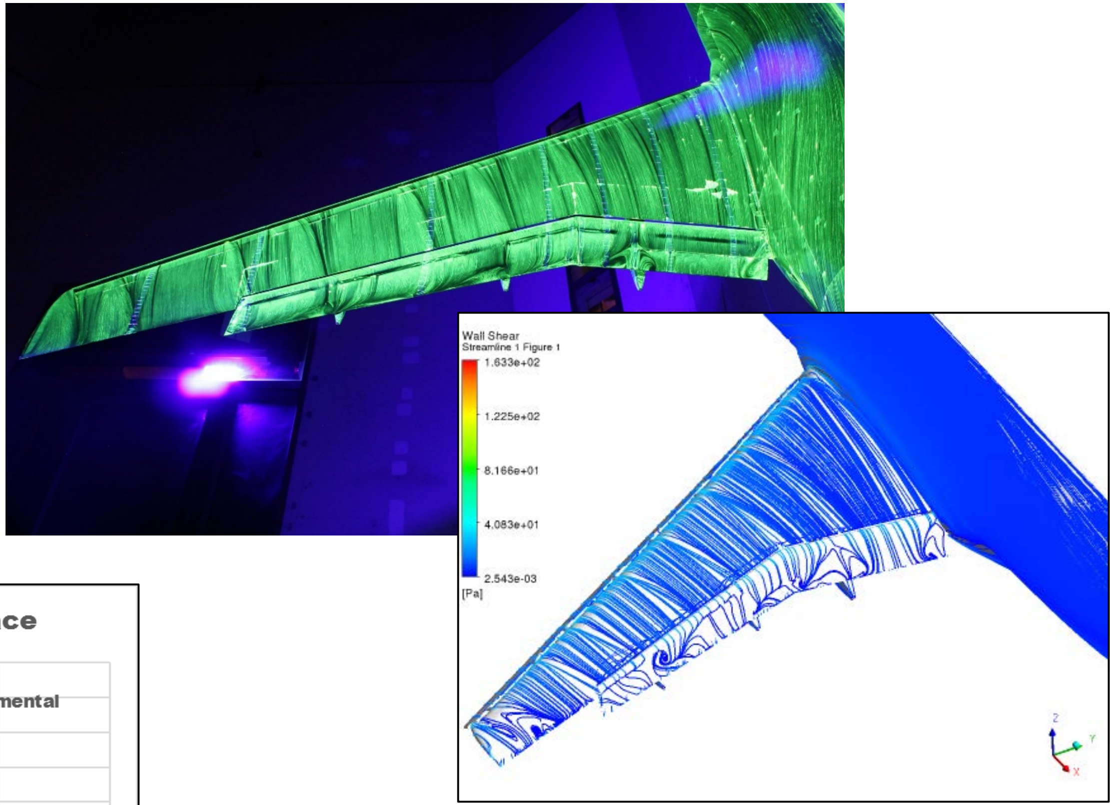
Software Scalability – Example

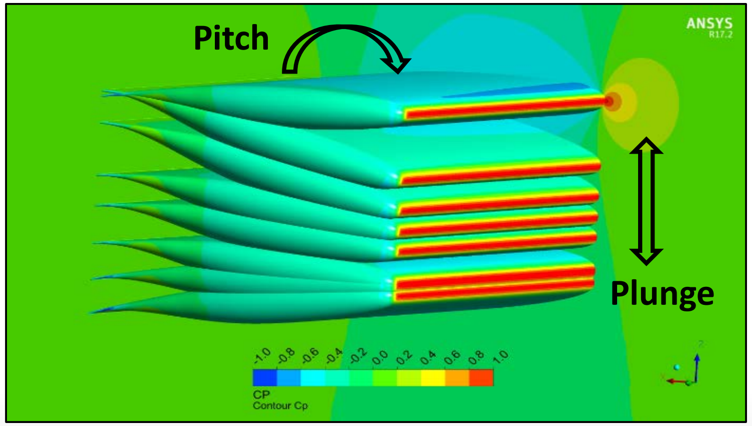
- Improvements Through Partnership with Cray

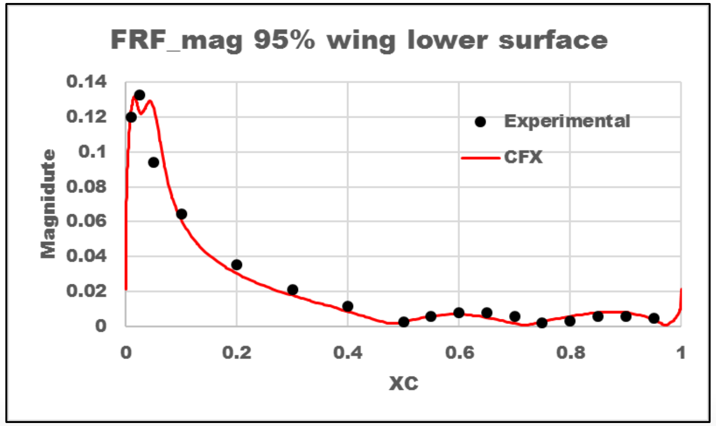
- Support in high-profile workshops
- Objective: CFD code validation
- Motivation: publications, comparison of CFD results with experiments as well as various industry and academic codes

Workshop: High Lift Prediction Workshop (HiLiftPW3)
Test cases : Case-1 – NASA High-Lift Common Research Model Grid convergence study.
Case-2 – JAXA Standard Model Nacelle Installation Study.



Workshop: Aeroelasticity Prediction Workshop (AePW-2)
Test cases : Case-1 - wing forced oscillations
Case-2 - wing flutter prediction





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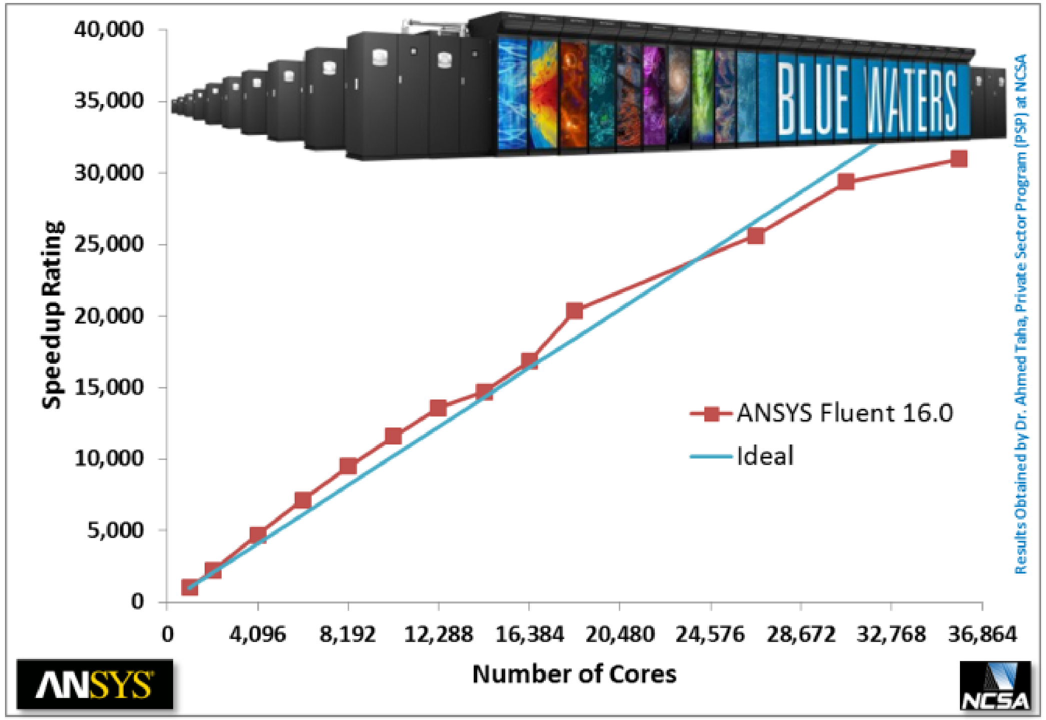
Software Scalability – Example

- Improvements Through Partnerships with Supercomputing Centers



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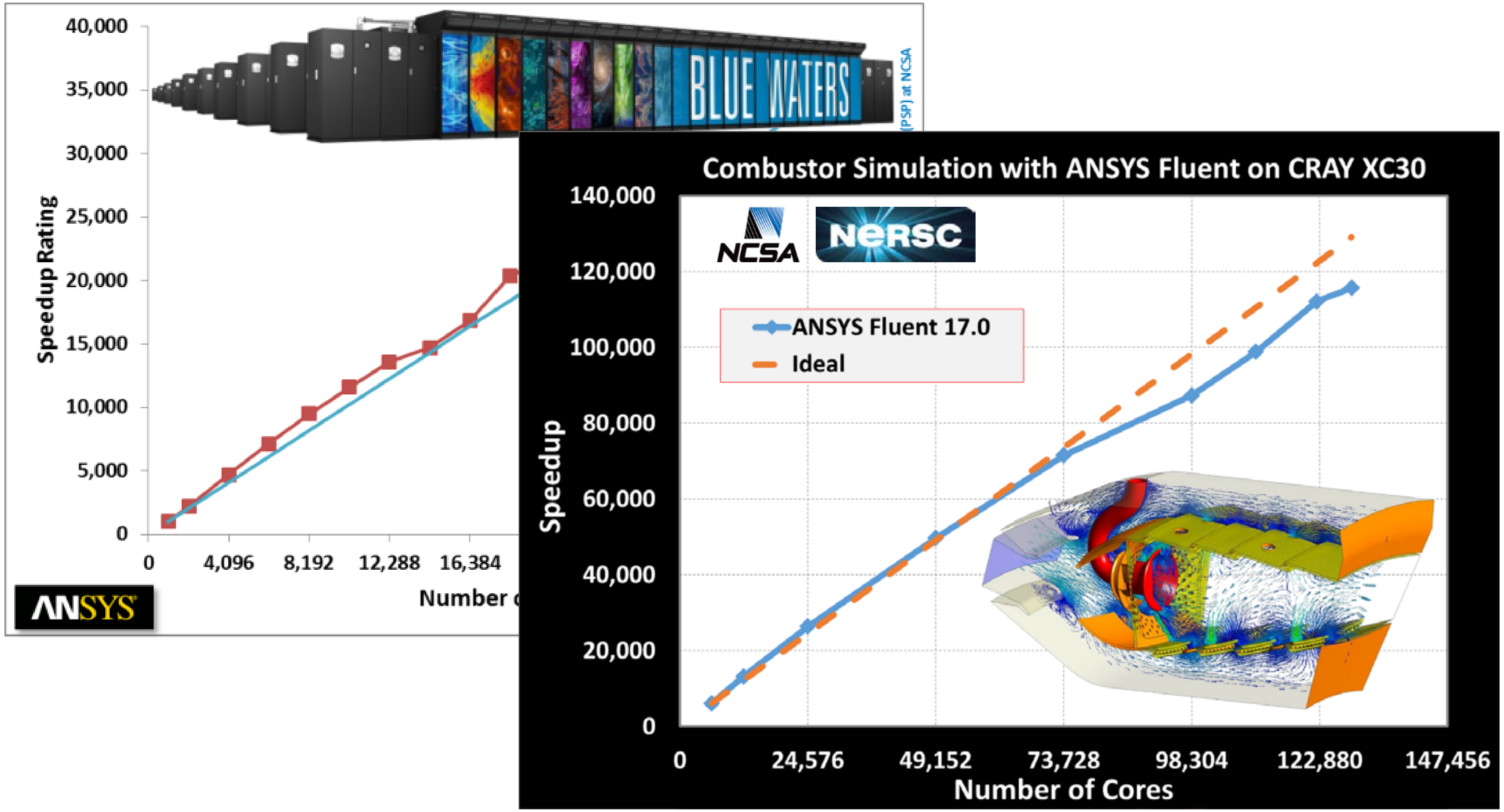
Software Scalability – Example

- Improvements Through Partnerships with Supercomputing Centers



09/09/2015 ANSYS press release: “ANSYS and Cray…have smashed the previous simulation world record by **scaling Fluent to 129,000 compute cores**”

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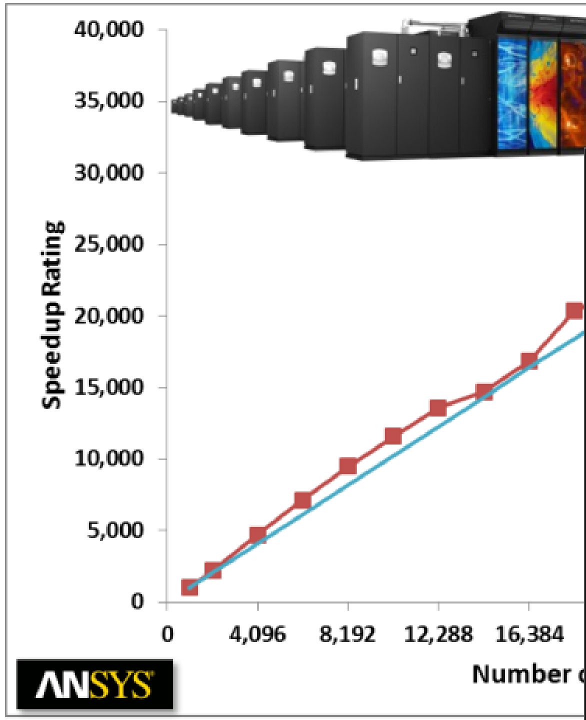
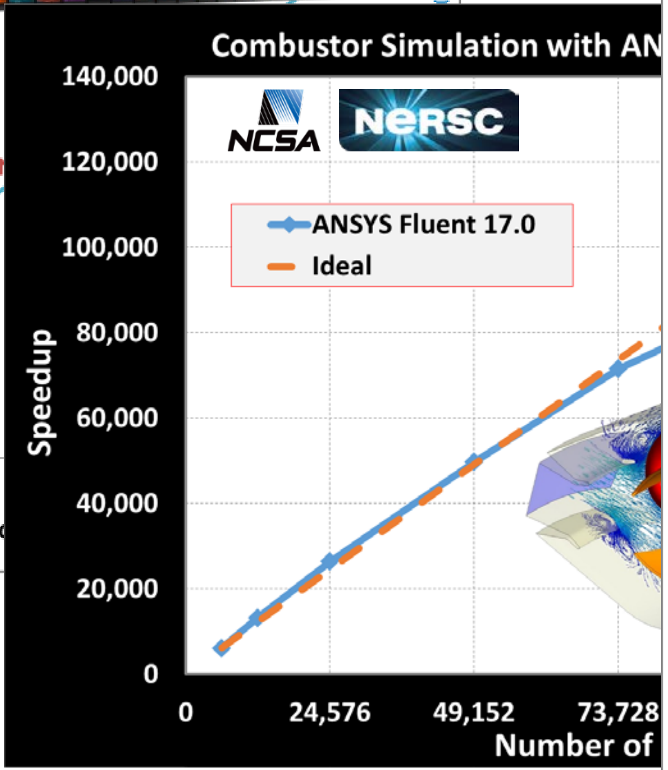
Software Scalability – Example

- Improvements Through Partnerships with Supercomputing Centers





09/09/2015 ANSYS press release: “ANSYS and Cra
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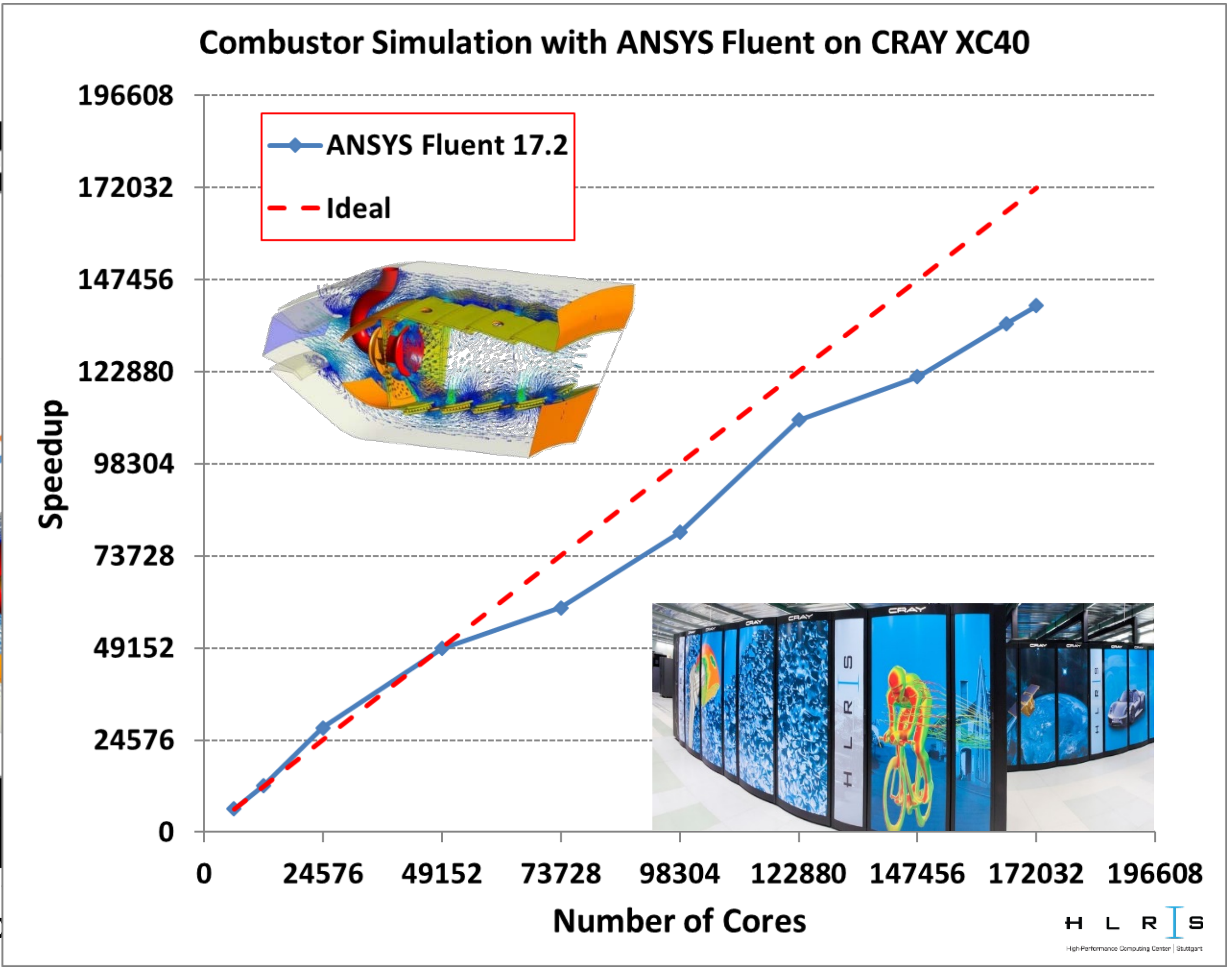

11/16/2016 ANSYS press release: “ANSYS, Cray and HLRS set new supercomputing record by **scaling Fluent to 172,000 compute cores!**”

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Software Scalability – Example

- Improvements Through Partnerships with Supercomputing Centers

HLRS

HLRS – ANSYS Collaboration

- ANSYS, HLRS and Cray partnership achieves to set a new supercomputing record after working together for a year (2015-2016)
- ANSYS Fluent is scaled to over 172,000 cores on the HLRS supercomputer Hazel Hen, a Cray XC40 system
- 5x increase over the record set two years ago when Fluent was scaled to 36,000 cores

"This breakthrough in commercial software technology will offer both academic and industrial users the chance to leverage the full capabilities of our high performance computer in all areas of research and development."

Prof. Michael M. Resch, Head of HLRS

The work leading to this result was supported within the framework of the Peta-GCS project, which is funded by the Bundesministerium für Bildung und Forschung (BMBF) and the Ministerium für Wissenschaft, Forschung und Kunst (MWK) of Baden-Württemberg.

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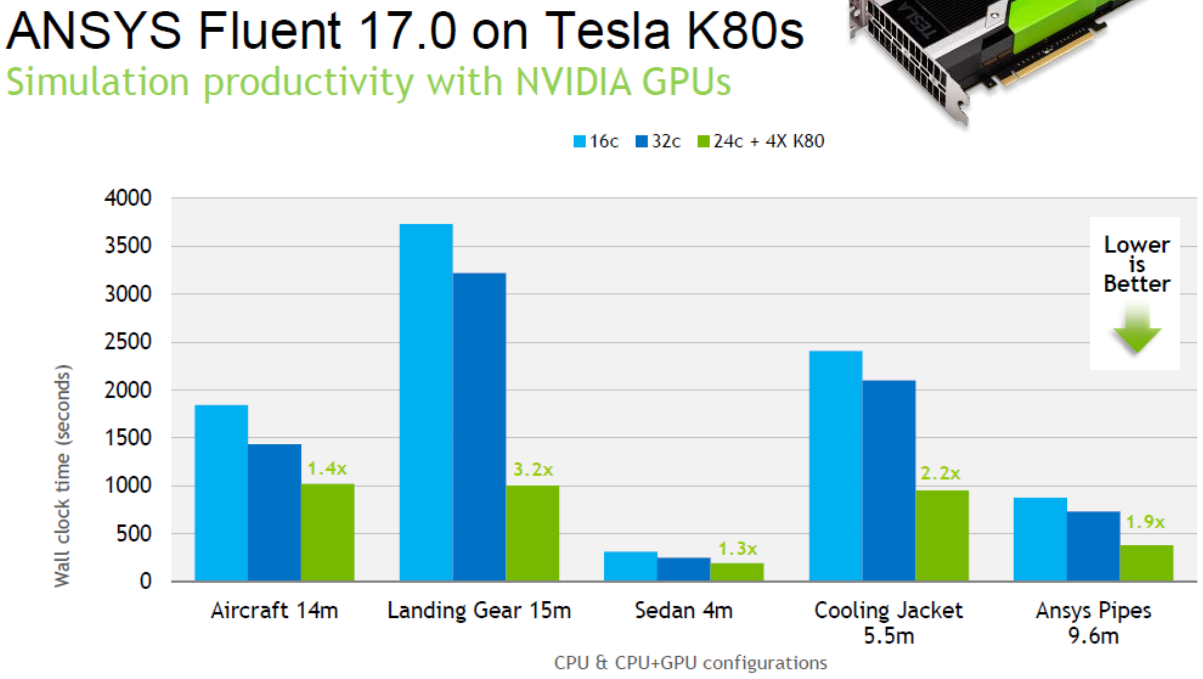
Software Scalability – Example

- Improvements Through Partnership with Nvidia and Intel



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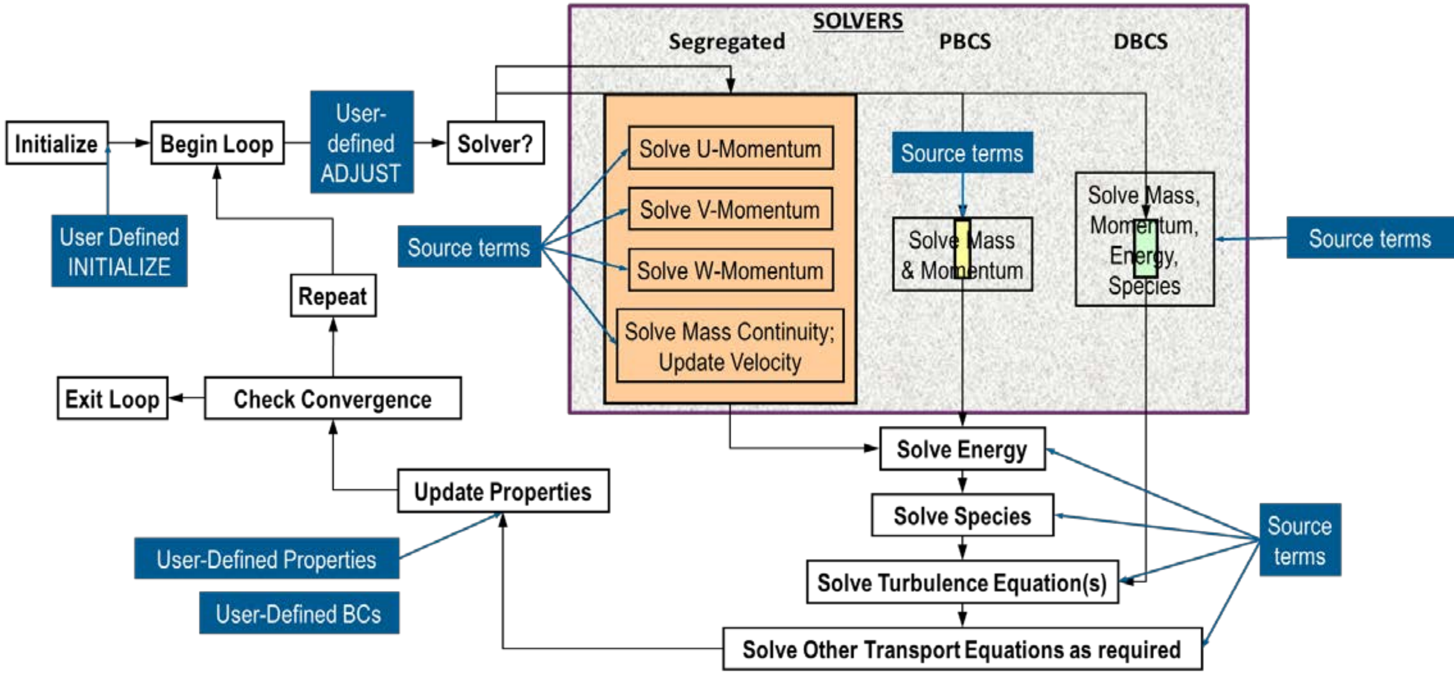
Software Customization – Limiting Factor?!

For simulating high-end fluids physics in industrial and research applications, there is a need for:

- A vast array of built-in capability.
- User-access to the underlying equations and solver.

…while retaining the benefits of using a stable, commercial code.

High-Level Overview of User Access to the Fluent Solver



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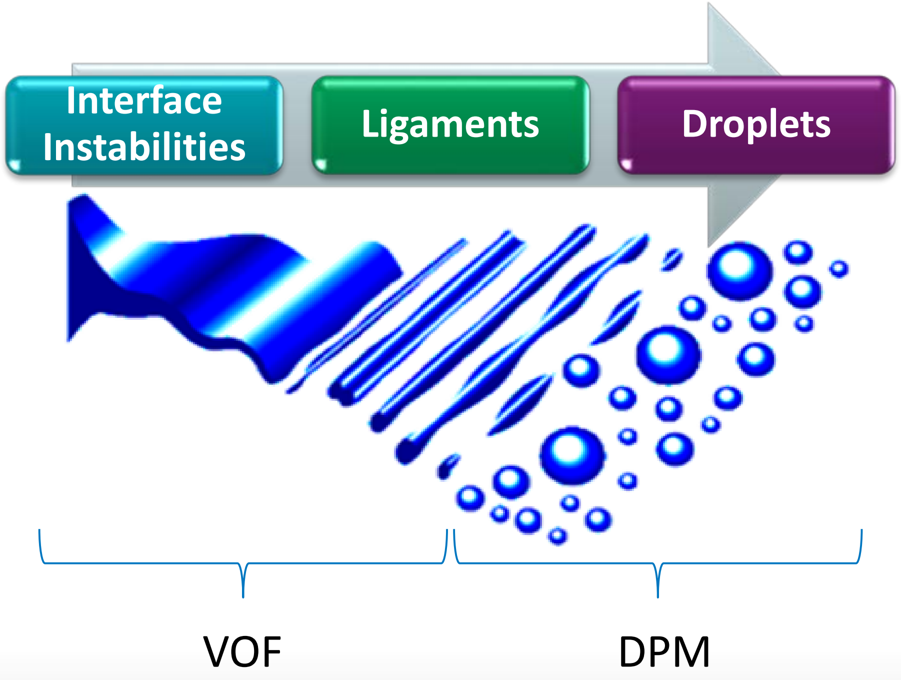
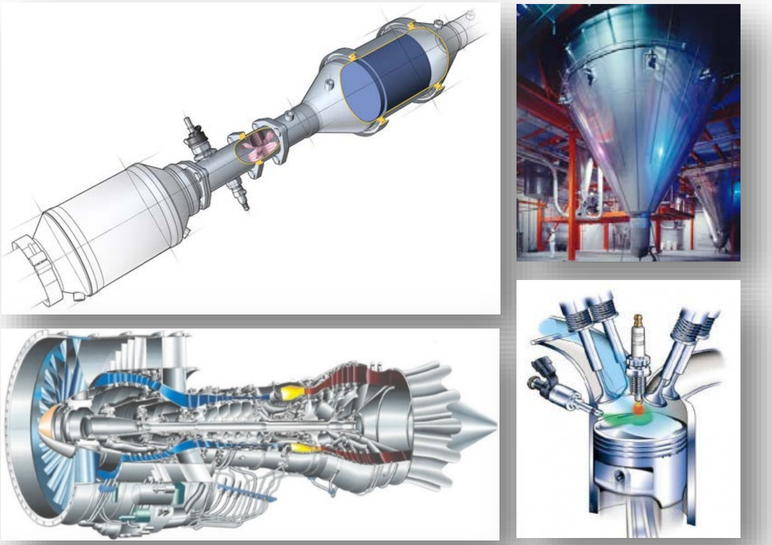
Source: Solve. Report by US Council on Competitiveness and Intersect360 Research, Oct 2014.

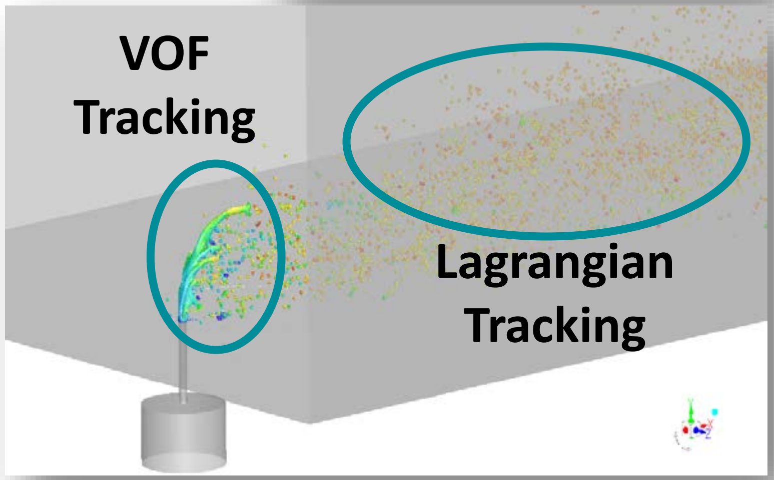
Software Customization – User-Defined Function (UDF) Example

- Spray Modeling Combining Volume of Fluid with Discrete Phase Modeling

- Need accurate resolution of break-up behaviors
- VOF used to resolve free-surface of stream and ligaments
- UDF detects small, nearly spherical droplets and transfers them to computationally-efficient Lagrangian particle tracking







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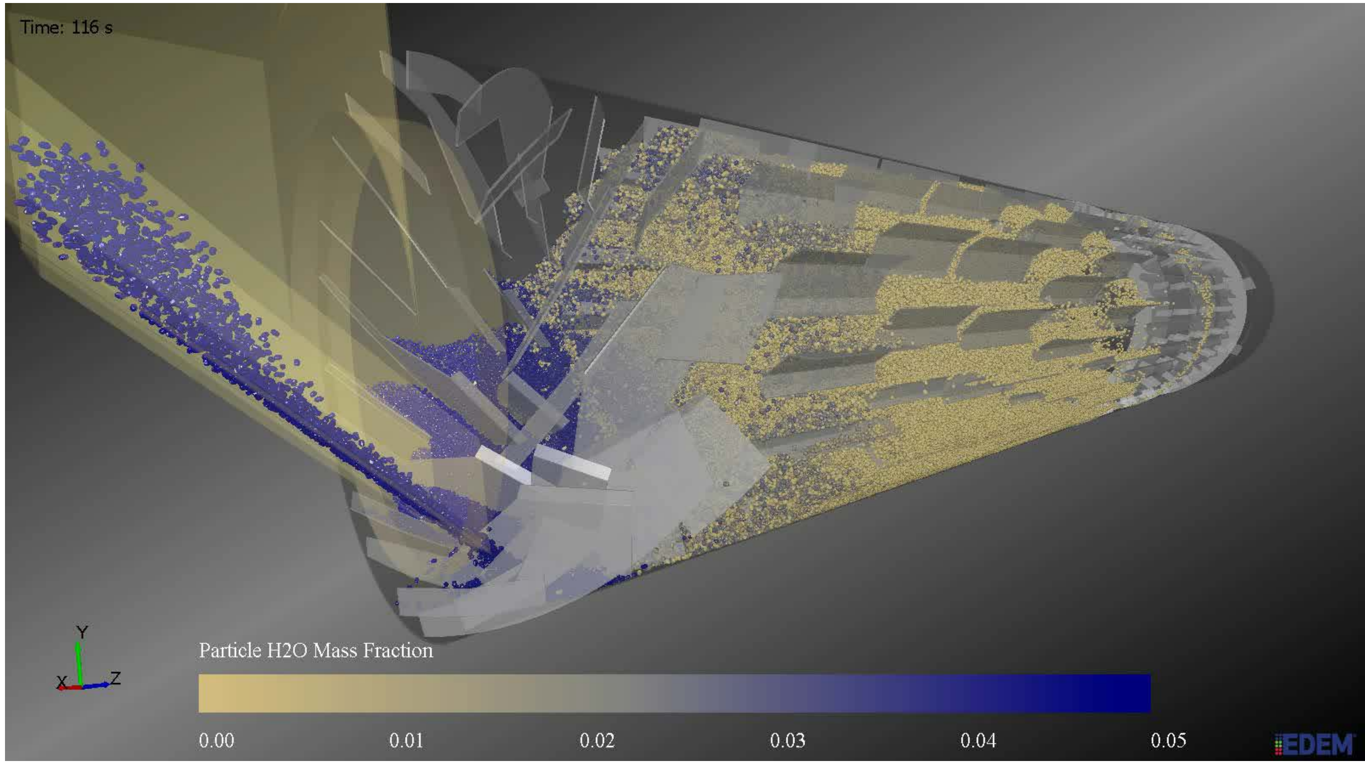
Software Customization – User-Defined Function (UDF) Example

- Coupling Fluent with EDEM

- Continuum fluid flow solved in Fluent
- DEM particle flow solved in EDEM
- UDFs used to add source terms into Fluent to include effects of particle flow on continuous phase



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Key Takeaways

- **Increasingly we see interest from our users for higher-fidelity CFD simulations**
- **We are pleased to have the ability to leverage large Cray systems worldwide for breakthrough simulations**
  - ANSYS technical people have access to Cray systems for software development
  - Cray technical people on site at the large HPC centers (like NCSA, NERSC, HLRS) can work directly with our users
- **Thanks to strategic partnership with Cray and supercomputing centers we have reached new supercomputing heights of CFD performance and scalability**
  - On-going projects to push the envelop on ANSYS scalability and overall performance
- **We are committed to delivering the most comprehensive suite of customization capabilities that can help addressing the most complex research challenges**

http://www.ansys.com/About-ANSYS/Partner-Network/high-performance-computing-partners/cray

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