

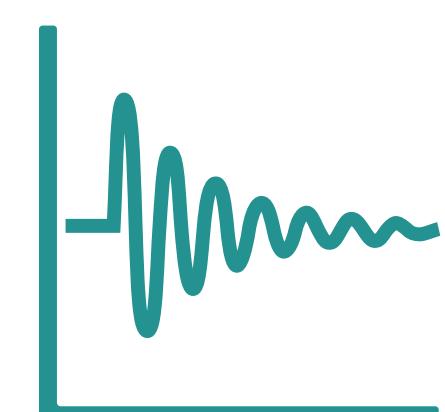
CFD in Aviation

Computational Fluid Dynamics

Numerical finite Analysis

What is CFD?

What are the first words in your mind?



C Computational

+
F fluid

+
D dynamics

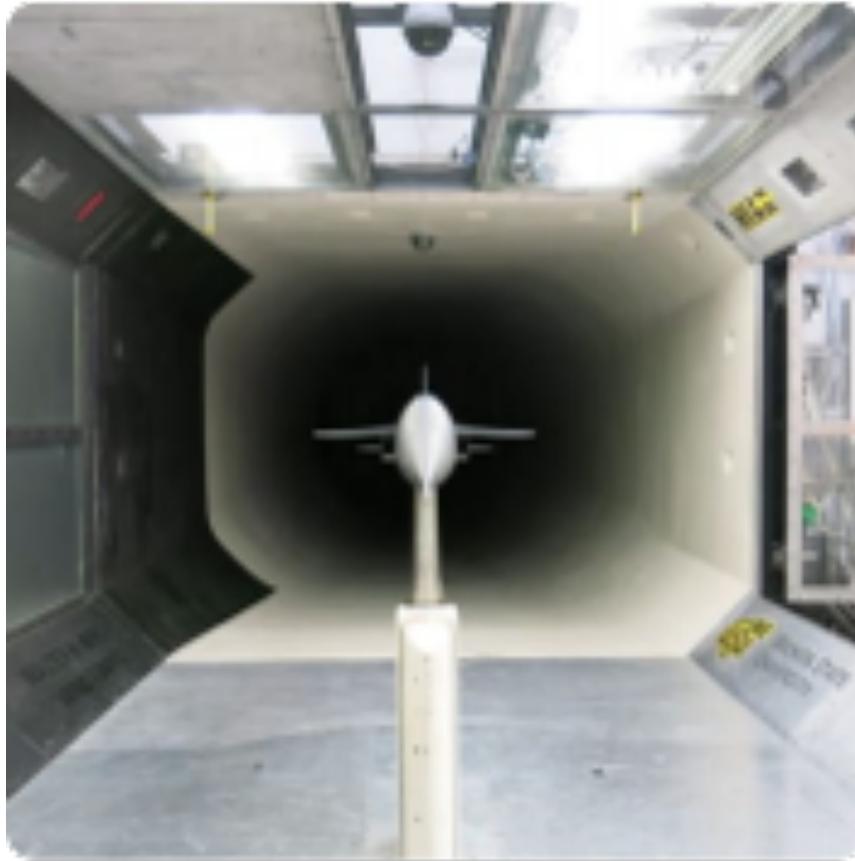
Tool: Computer

Object: Water/Air

Motion: Dynamic

Computational fluid dynamics (CFD) is the use of applied mathematics, physics and computational software to visualize how a gas or liquid flows

Where can we use CFD in Aviation?



WindTunnel Testing

CFD has replaced traditional wind tunnel testing and is used to evaluate the aerodynamics of aircraft and optimize fuel efficiency.



Aircraft Engine Design

CFD is used to optimize design and performance of aircraft engines by modeling the flow of air and fuel through the engine.



Comfort & Safety

CFD is used to design optimized cabin and cockpit ventilation systems that ensure passenger comfort and safety.



Takeoff & Landing

CFD is used to better predict takeoff and landing distances, improving safety and efficiency.

Why CFD?

Cheaper

Cheaper than wind tunnel!

Future

Computer is the start of future technology!

Data-Driven

More detailed, quantitative analysis!

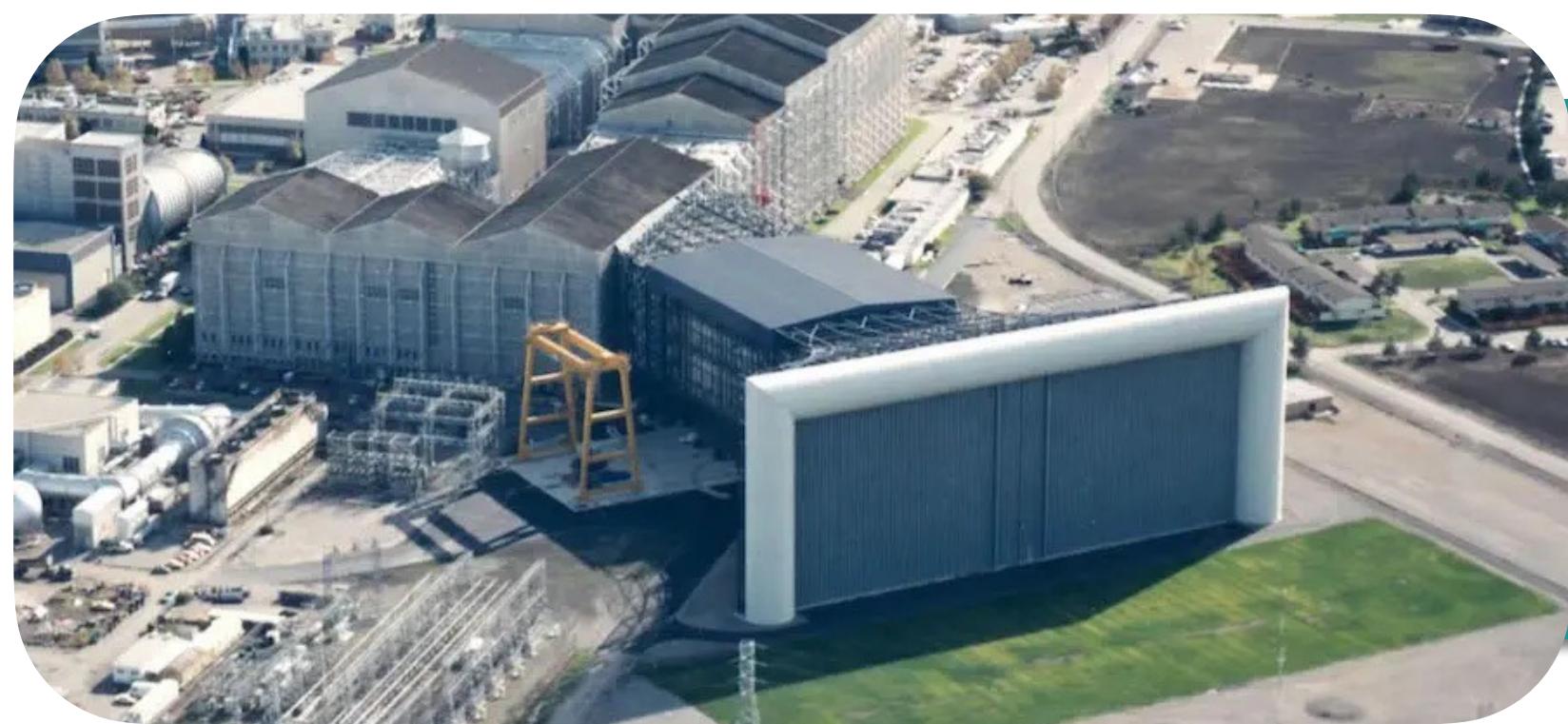
Why CFD?

Cheaper

No physical prototypes

No huge-scale equipment

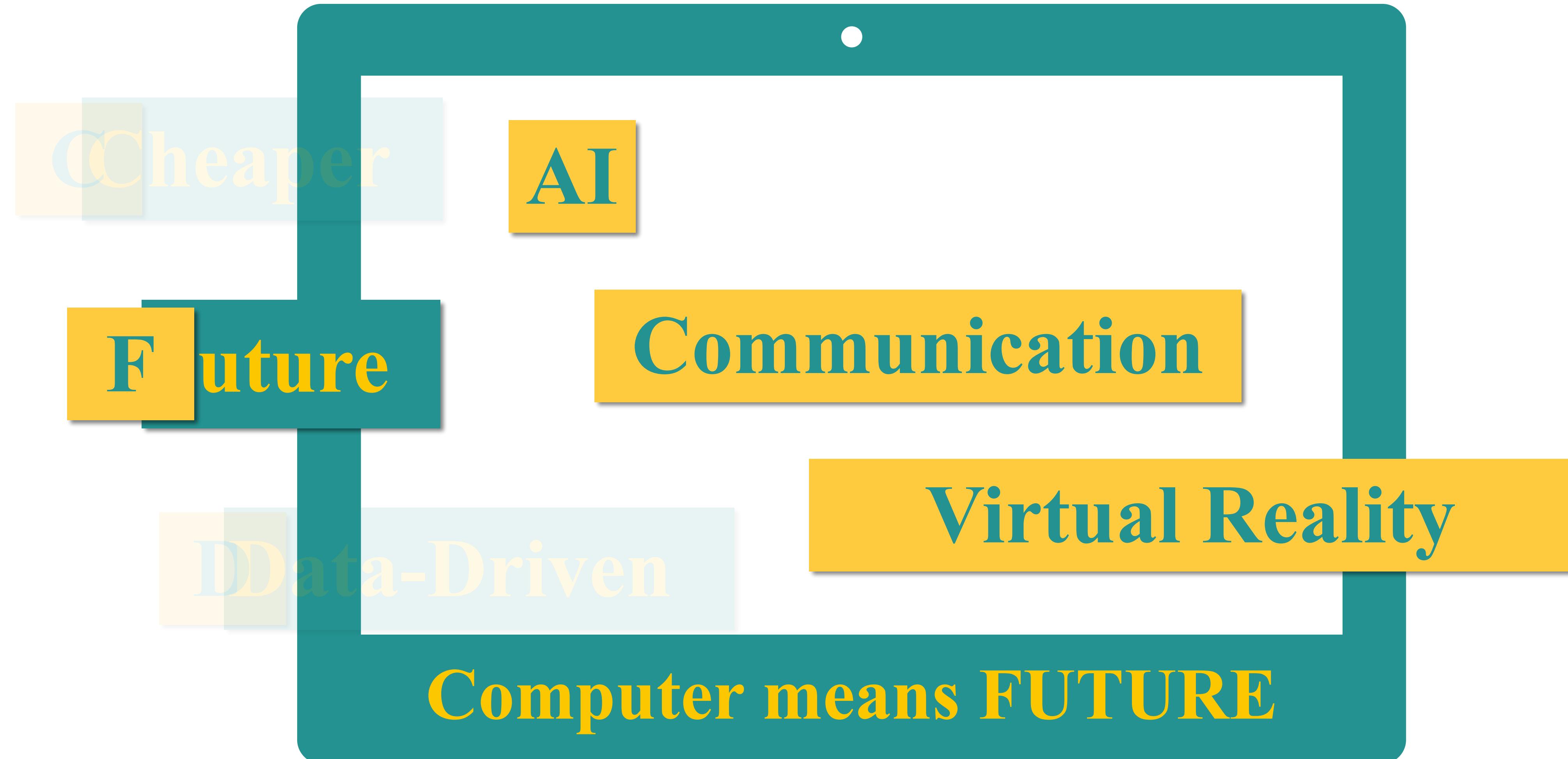
Shorter simulate time



NASA NFAC
\$529,305,378

What if... We want to test something larger?

Why CFD?

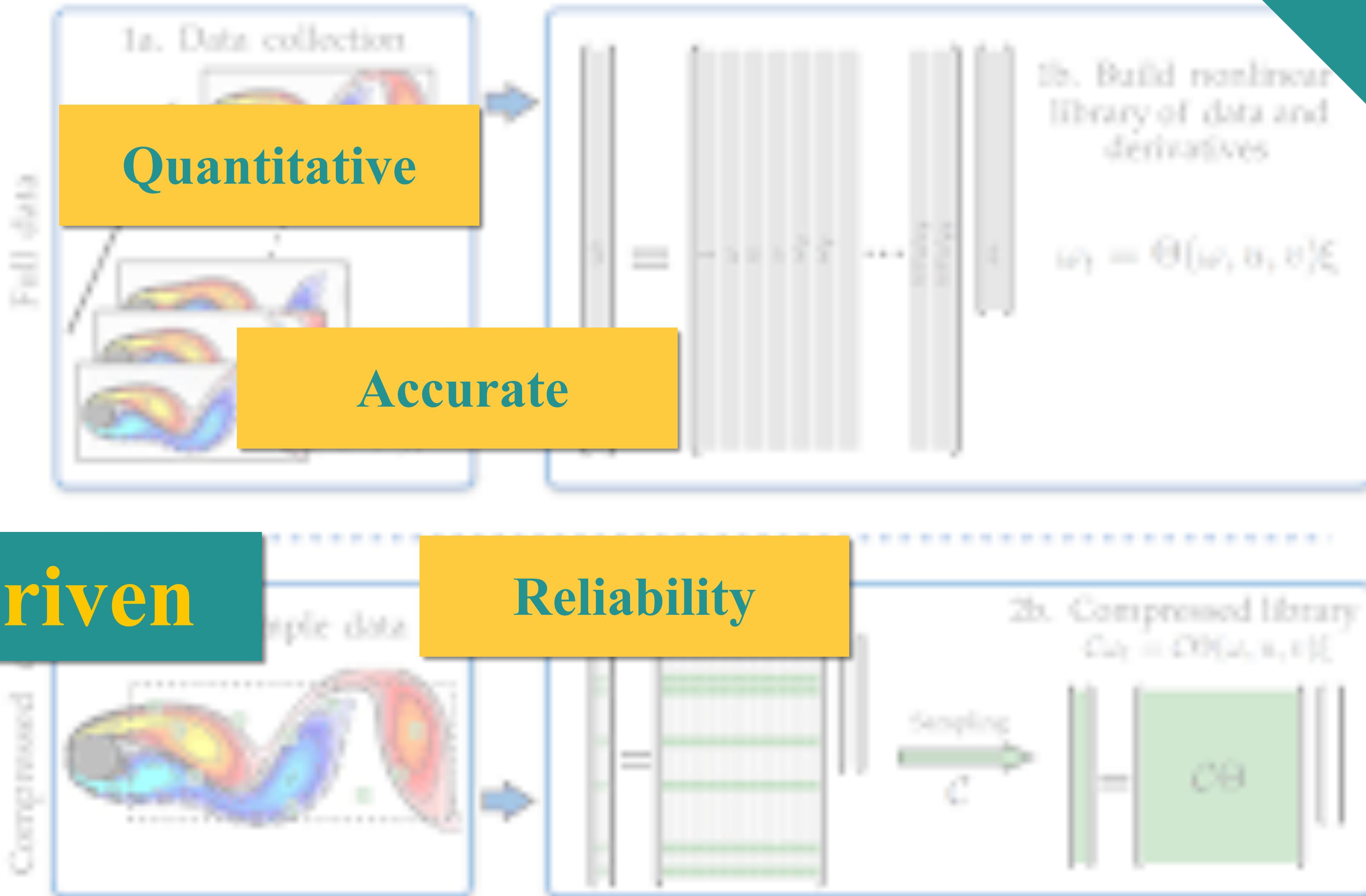


Why CFD?

Cheaper

Future

Data-Driven



What is CFD, really?

C F D = C + FD

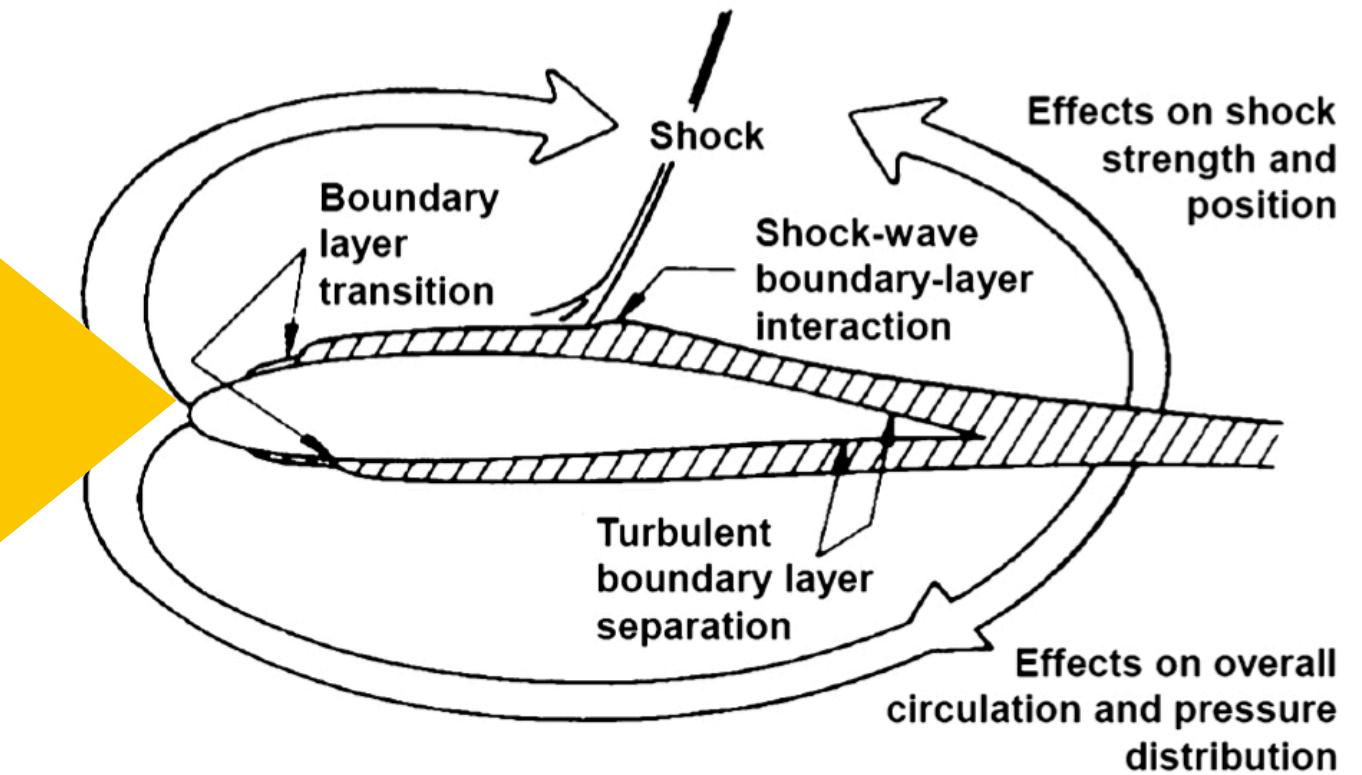
Fluid Dynamics

$$\nabla \Delta \sum \int$$

$$Ma + Cv + Kd = F(t)$$

Math

Physics



N-S

$$\frac{d\vec{v}}{dt} = \frac{\partial \vec{v}}{\partial t} + (\vec{v} \cdot \nabla) \cdot \vec{v} = \vec{f} - \frac{1}{p} \nabla P + \frac{\nu}{3} \nabla (\nabla \cdot \vec{v}) + \nu \Delta \vec{v}$$

Equation

What is CFD, really?



Can't Solve It!!

$$\text{N-S} \quad \frac{d\vec{v}}{dt} = \frac{\partial \vec{v}}{\partial t} + (\vec{v} \cdot \nabla) \cdot \vec{v} = \vec{f} - \frac{1}{p} \nabla P + \frac{\nu}{3} \nabla (\nabla \cdot \vec{v}) + \nu \Delta \vec{v}$$

Equation

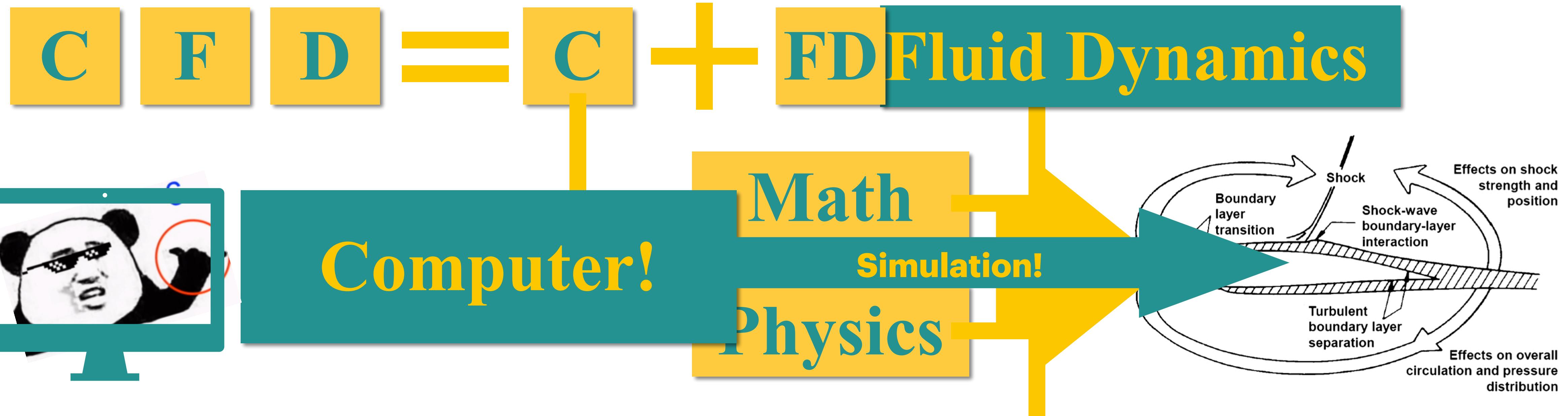
Win \$1 Million Solving The Navier Stokes Equations !



universe.laws (52) ▾ in #mathematics • 5 years ago



What is CFD, really?



N-S

$$\frac{d\vec{v}}{dt} = \frac{\partial \vec{v}}{\partial t} + (\vec{v} \cdot \nabla) \cdot \vec{v} = \vec{f} - \frac{1}{\rho} \nabla P + \frac{\nu}{3} \nabla (\nabla \cdot \vec{v}) + \nu \Delta \vec{v}$$

Equation

C+FD—History

Eras

Algorithms

Computers

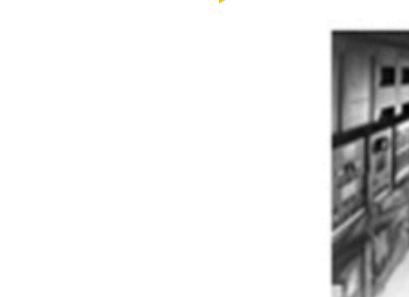
*Evolution
of CFD*

CFD ERA3
Hybrid RANS/LES

CFD ERA2
Euler, RANS

CFD ERA1
Nonlinear potential

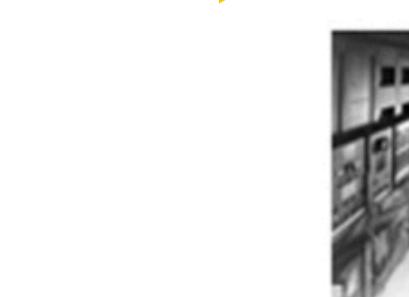
Pre-CFD
ERA



ENIAC

1945

1945



CDC-6600

1965



CRAY-1

1976



Clusters

Circa
1990



Quantum
Computing?
When?

*Evolution
of Super
Computing*

AVT-183

AVT-161

AVT-316

Mature
Application

HLPW-1

DPW-1

F-22

Eurofighter

VFE 1

Jameson

Murman

F-16

TF-8A

Von
Neumann

C-141

F-86

Design for
attached flow

Design with
controlled
vortex separation

Design with
chaotic
separation

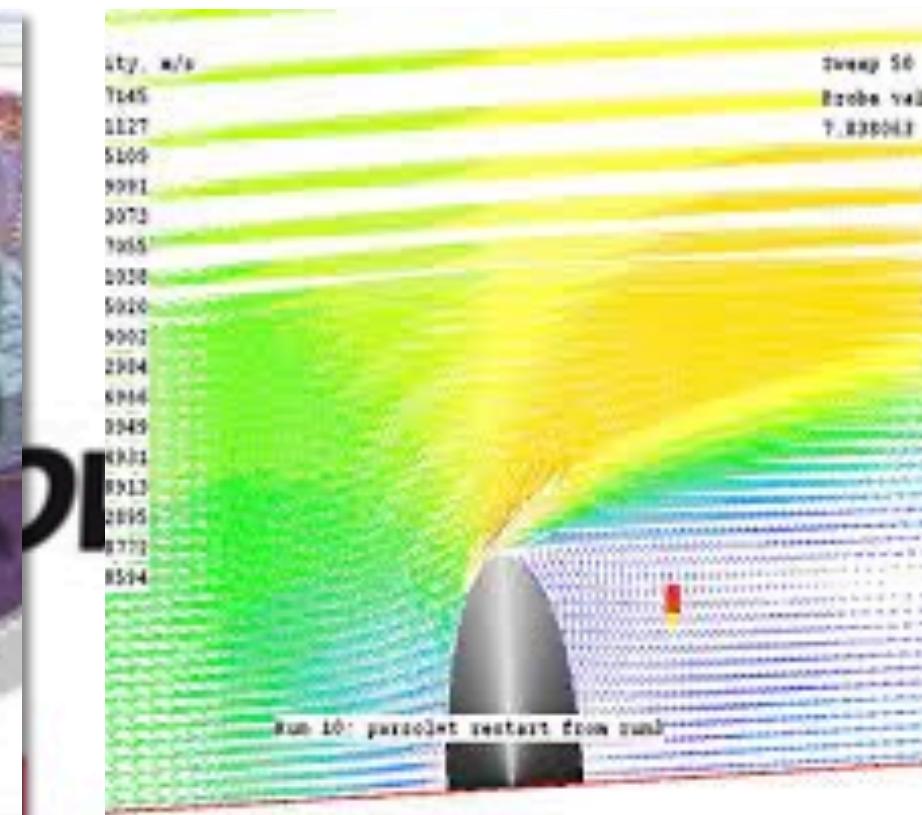
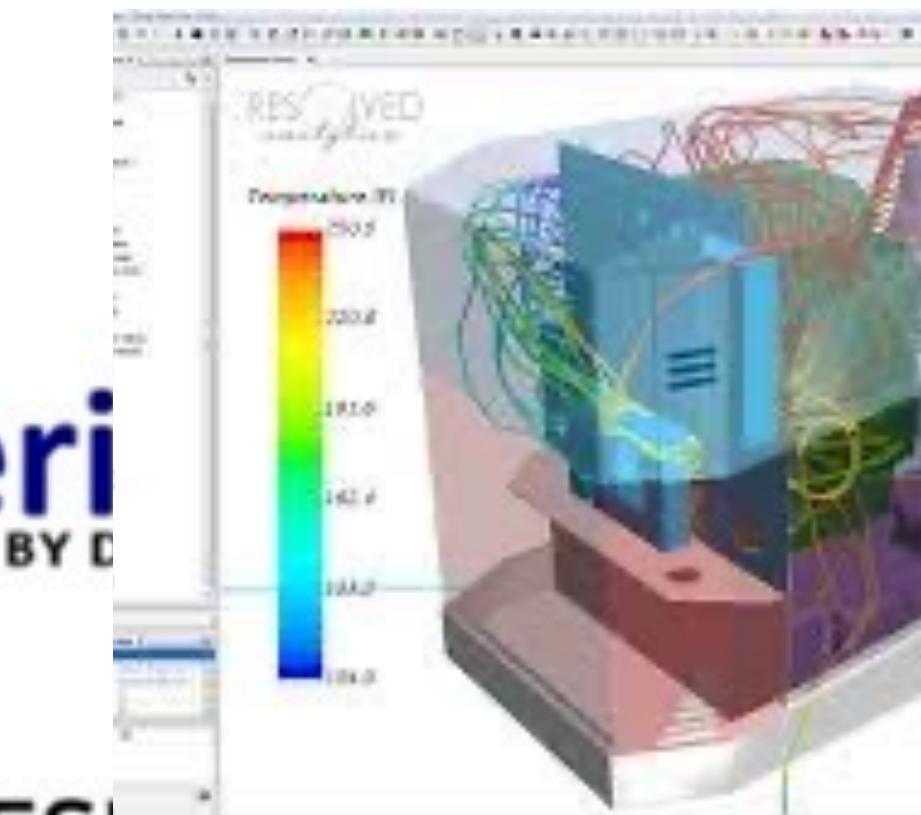
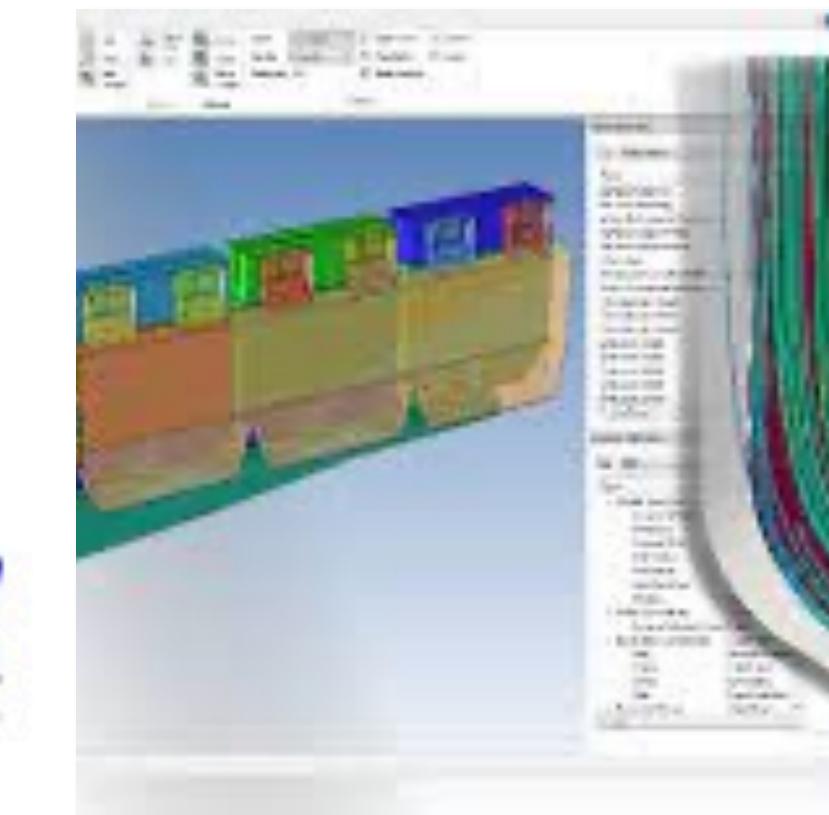
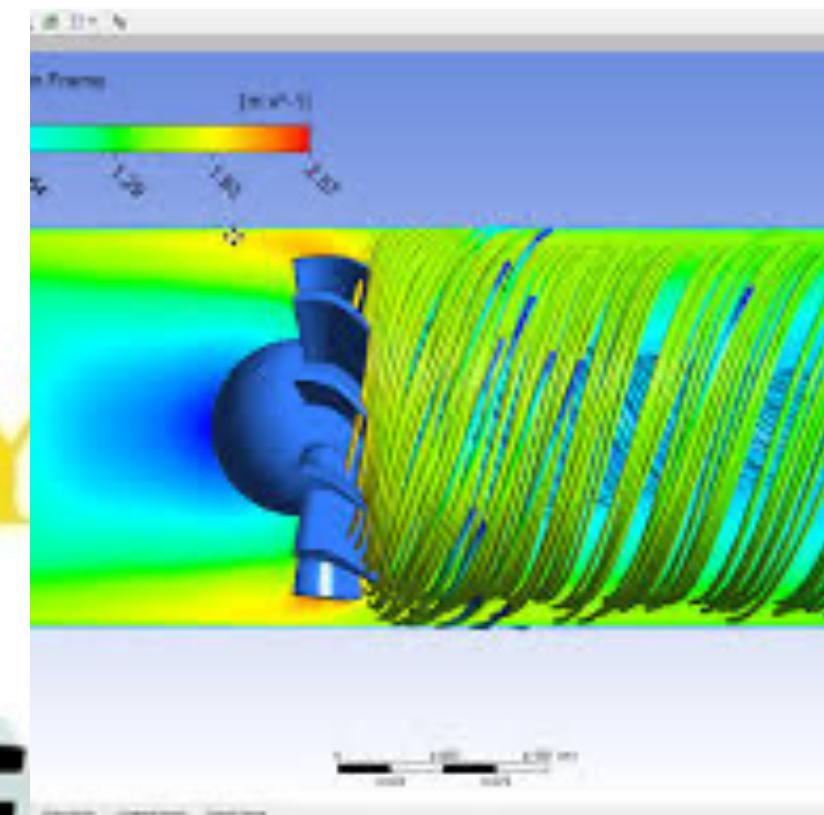
Rapid
Development

Specialized
Computation

Next Leap?

C+FD—Now Software

ANSY



**NVERGE
SOFTWARE**



SHIPFLC
for naval architect

Ansys

OpenFOAM®

SESAM HydroD

OpenFOAM®

POINTWISE

**SIEMENS
STAR-CCM+**

CHAM

HYDROCOMP[®]

GridPro
Superior Engineering Solutions

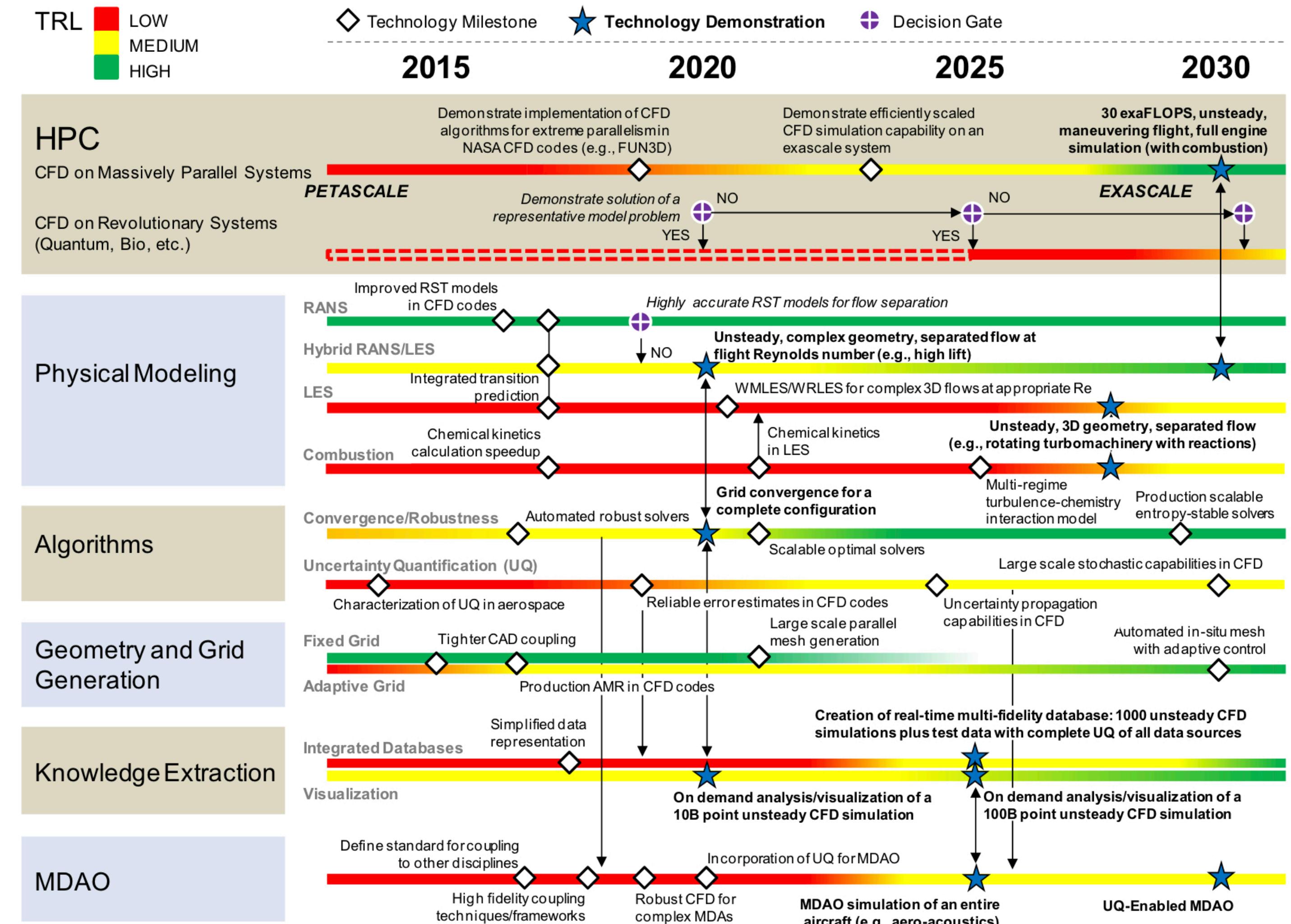
C+FD—Future

NASA CFD 2030

Modeling

Algorithms

Geometry



Questions :)

1 What is CFD means?

- Computer financial dynamics A
- Competition in fly dynamics B
- Computational fluid dynamics C

2 Why use CFD in Aviation ?

- No other choice A
- Cheaper, future, data-driven B
- It is not related to computer C

3 CFD software include Ansys, Open foam

T.

F.

That's all! Thank you!

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