Forum TERATEC 2014

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2004-2014
10 ans de calcul haute performance à Airbus

Enseignements et perspectives

Airbus

- A world leading aircraft manufacturer
  Customer focus, commercial know-how,
  technological leadership , manufacturing efficiency
- A world wide presence with strong European roots
  Subsidiaries in United States, China, Japan, India and in the Middle East

A320 Family	A330 Family	A340 Family	A350 XWB	A380
This eco-efficient product line, including the A318, A319, A320 and A321, cover the 100-220 seat market	The highly-successful and versatile widebody A330 Family conducts a variety of operations around the world	The four members of the A340 Family can carry from 260 to 400 passengers on the world's longest routes	The brand new, state-of-the-art, A350 XWB address the needs of the 270 to 350-seat market	The efficient A380 double-deck jetliner is a game changer that has become the new icon in aviation

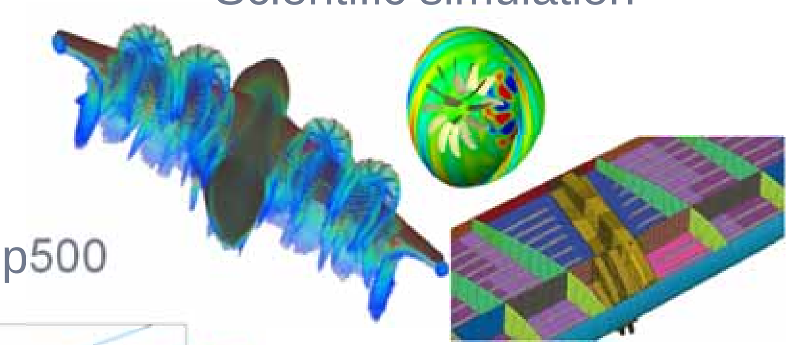
A350XWB : entering in service this fall

Airbus	May 2014
Total orders	14018
Total deliveries	8504
In operation	7824

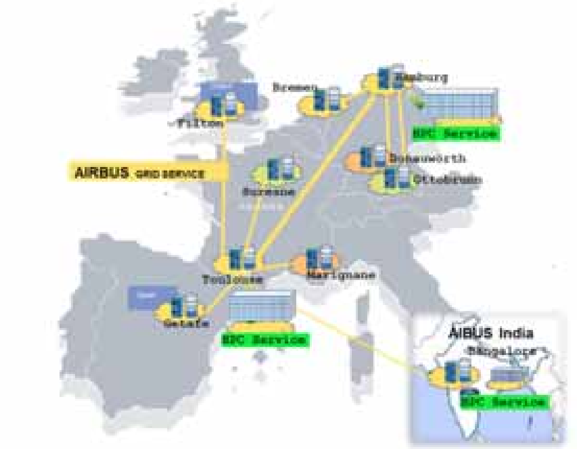
HPC (High Performance Computing) at Airbus

HPC as a service

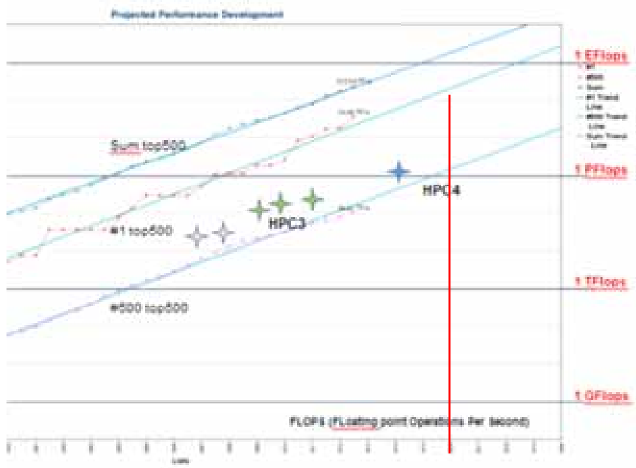
Scientific simulation



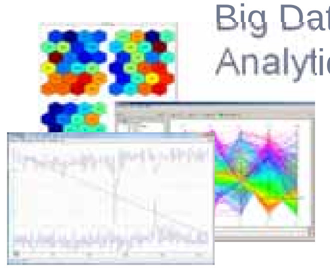
Hybrid cloud



Within Top500



Big Data Analytics



10 years of High Performance Computing : Lessons learnt & perspectives

- Infrastructure
- Applications
- Usage

Vector computers → Scalar clusters → ?

Infrastructure (1/2) | Applications | Usage

2004

- Internal assembly of proprietary hardware
- Computing centers with specific infrastructure layout
- Limited specific needs for electrical power

2014

- Integrated HPC means rented as a service,
  long term internal assets / short term external CPU hours
- Hybrid cloud linking HPC means & customers
- Electrical power needed for a POD is ~ 0,5 MW

Performance Optimized Datacenter (POD)

HPC4 root $

> Location :	Toulouse, Hamburg
> Containers :	3 PODs
> Servers :	2 320
> Cores :	55 680
> Memory :	270 TB
> Local Storage :	1 500 TB
> Shared Midterm Storage :	750 TB
> Shared Computing > Storage :	1 800 TB
> Energy Efficiency	PUE < 1.2

Super computer in a container
Outsourced service
Energy Efficiency (PUE 1.25)
990 TFlops though 55680 cores / 385 TB Memory
1,8 TB Scratch & 500 TB Mid-Term Storage

Infrastructure (2/2) | Applications | Usage

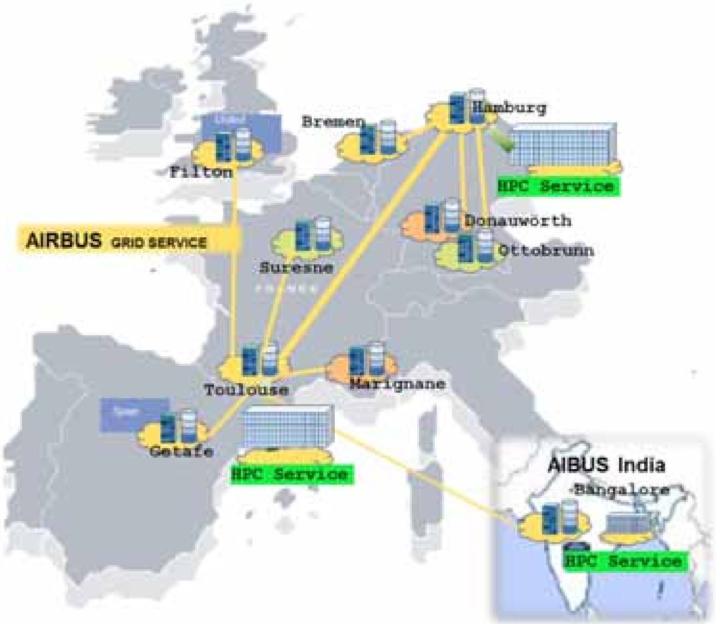
2004

- Execution centric operations (select your CPU)
- Batch queuing (CPU fair share)
- Local computing centers setup & execution instructions
- No data management

2014

- Data centric operations (keep operations within POD)
- Grid computing optimize CPU, data access, licences…
- All scientific computing means on the same cloud
- Virtualization: homogeneous execution model to support
- Support for efficient HPC data management

Grid computing



Infrastructure | Applications | Usage

- ➔ More energy efficiency (e.g. GPU, Manycore…)
- ➔ More configurable nodes (CPU/Memory/Communication balance)
- ➔ Smaller & embarked capable units

- ➔ Service centered operations on fully virtualized infrastructure
- ➔ Integrated & efficient HPC data management (e.g. meta-data warehousing)
- ➔ Mutualized infrastructure between HPC & BigData (e.g. meta-scheduling analytics)

Think performance first, but not only :
integration & usability will matter for aeronautic !

AIRBUS

Infrastructure | **Applications** (1/2) | Usage

2004

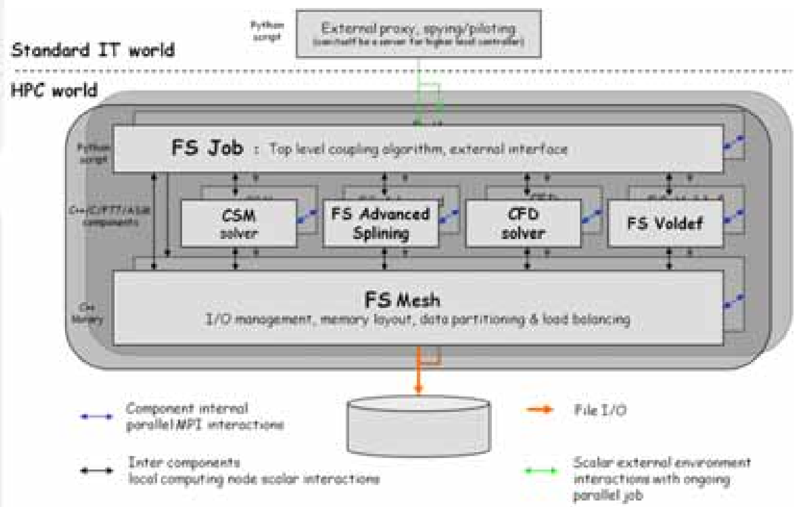
- Monolithic solvers per discipline, limited code re-use
- Execution patern is computing center dependant
- Job handle one run of the solver

2014

- Multi-disciplinary components dynamically coupled
- Internal standard for code re-use (I/O, mesh handling...)
- Standard execution pattern on virtualized infrastructure
- Job launch parallel server providing solver service
- Meta-scheduling several jobs on same processors

Modularity in HPC applications

(e.g. FlowSimulator open-source solution)



FS : Flow-Simulator
CFD : Computational Fluid Dynamics
CSM: Computational Solid Mechanics

Infrastructure | **Applications** (2/2) | Usage

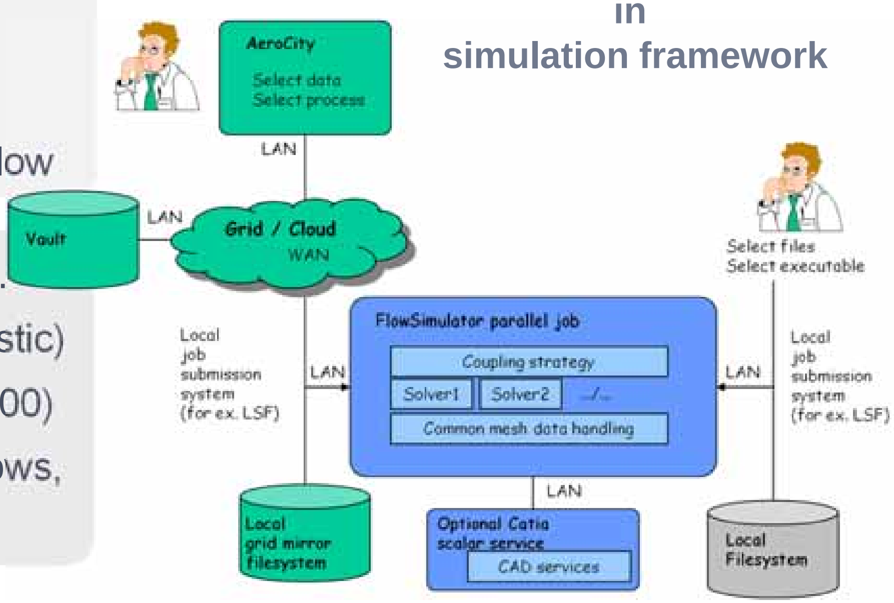
2004

- Mostly aerodynamic simulations
- Mono-disciplinary & static
- One job uses significant part of HPC means
- Many manual interventions in HPC simulation workflow

2014

- Aerodynamic, stress, electromagnetism, accoustic…
- Unsteady & multi-disciplinary (e.g. aero-vibro-accoustic)
- One job use small part of HPC means (e.g. 100/10000)
- Robustness improvement of HPC simulation workflows, now automated & embedded in more complex ones

Integration in simulation framework



LAN: Local Area Network
WAN : Wide Aera Network
CAD : Computer Aided Design

Infrastructure | **Applications** | Usage

➔ Higher level common standard libraries as building blocks for solvers : I/O, mesh handling, communication with outer world…

➔ Software ecosystem convergence : Grid⇔Cloud and HPC⇔BigData

➔ Integration in dynamic simulations of systems

➔ Integration of HPC aspects in commercial simulation frameworks with improved process & data management capabilities (e.g. self-enriching surrogates)

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Infrastructure | Applications | **Usage** (1/2)

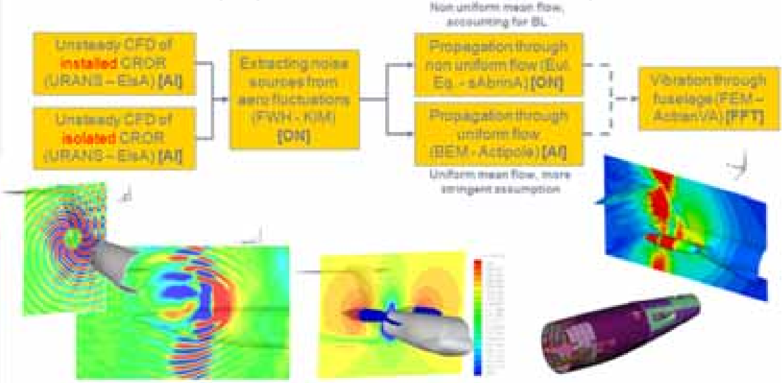
2004

- Capability to predict trend
- Support to design evaluation

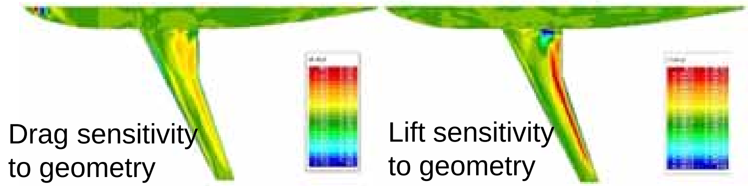
2014

- Capability to predict absolute value in several areas
- Production of design caracterization data
- Optimization & Sensitivities (full end-to-end adjoint)
- Multi-level / multi-disciplinary optimization

Multi-disciplinary applications
(e.g. aero-vibro-accoustics)



Advanced optimization & sensitivities
(e.g. full end to end aero CFD chain adjoint)



Infrastructure | Applications | **Usage** (2/2)

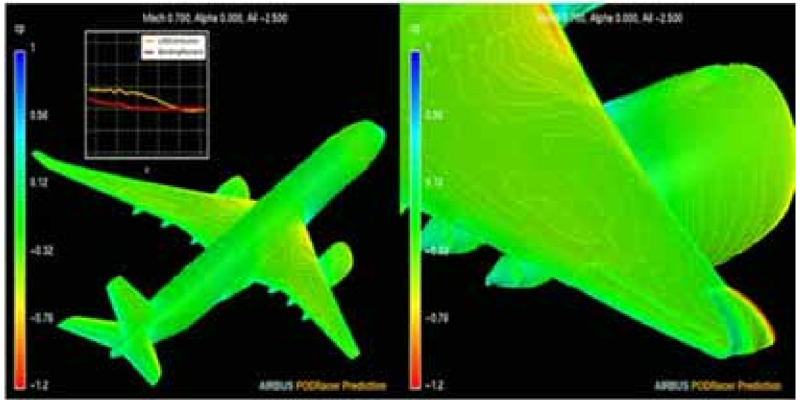
2004

- Usage by specialists
- HPC steps separated from global process
- HPC results thoroughly reviewed before being used

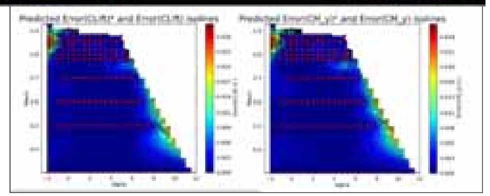
2014

- Usage by large number of engineers
- HPC transparently embedded in process
- Joint extended enterprise simulations with big partners

HPC transparent usage



CFD self-refining surrogate model using POD



CFD : Computational Fluid Dynamics
POD : Principal Orthogonal Decomposition

Infrastructure | Applications | **Usage**

- ➔ Capability to predict absolute value in all the flight domain
- ➔ Interactive HPC evaluation in the loop of normal simulations
- ➔ Applied mathematics progress matching HPC improvements

- ➔ Usage by anyone from any environment, clarification of issue tracking
- ➔ Generalization of HPC to Small & Medium Enterprises sub-contractors
- ➔ Integrated early HPC co-simulations to support integrated design

Think performance first, but not only :
integration & usability will matter for aeronautic !

10 years of High Performance Computing : Lessons learnt & perspectives

Embark today all yesterday actors of HPC is not enough

We need also today the actors we want on board tomorrow

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