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

A350XWB: entering in service this fall

<table>
<thead>
<tr>
<th>A320 Family</th>
<th>A330 Family</th>
<th>A340 Family</th>
<th>A350 XWB</th>
<th>A380</th>
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<tbody>
<tr>
<td>This eco-efficient product line, including the A318, A319, A320 and A321, cover the 100-220 seat market.</td>
<td>The highly successful and versatile widebody A330 Family conducts a variety of operations around the world.</td>
<td>The four members of the A340 Family can carry from 260 to 480 passengers on the world’s longest routes.</td>
<td>The brand new, state-of-the-art A350 XWB addresses the needs of the 270 to 350-seat market.</td>
<td>The efficient A380, double-deck jetliner is a game changer that has become the new icon in aviation.</td>
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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

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

- 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)

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

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

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

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

Aerodynamic, stress, electromagnetism, accoustic…
Unsteady & multi-disciplinary (e.g. aero-vibro-acoustic)
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
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 ↔ Big Data

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)

Think performance first, but not only: integration & usability will matter for aeronautic!
• Capability to predict trend
• Support to design evaluation

2014
• Capability to predict absolute value in several areas
• Production of design characterization data
• Optimization & Sensitivities (full end-to-end adjoint)
• Multi-level / multi-disciplinary optimization

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

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

Drag sensitivity to geometry
Lift sensitivity to geometry
• 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

POD : Principal Orthogonal Decomposition

CFD : Computational Fluid Dynamics

CFD self-refining surrogate model using POD
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!
Embark today all yesterday actors of HPC is not enough
We need also today the actors we want on board tomorrow

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