Forum TERATEC 24

Challenges and Solutions of Migrating Computational Resources and VDI to the Cloud at CSTB

Context and Origins (2017): IS Master Plan

Start of the modernization project of our IS: 2017

The current CSTB infrastructure offering is at the end of its life with governance that is highly fragmented between the IT department and operational departments making direct purchases.

- Goal: To acquire a secure, modular, high-performance, and scalable infrastructure, integrating new market solutions, capable of supporting our projects.

Practices to evolve:

- Aging CSTB infrastructure that no longer meets the company's challenges (availability, capacity, security, flexibility)
- Dispersion of infrastructure acquisitions without overall coherence
- Service levels to address: BCP (Business Continuity Planning), video conferencing, increased traffic, telephony services, remote access, convergence of workstations, and development of collaborative tools, software factory, authentication, enterprise platforms, provisioning and scalability of environments, supervision, lifecycle management, etc.

Market evolution:

- Emergence of "cloud" architectures
- Growing security risks and vulnerabilities of data and systems

Infrastructure Modernization Program: Hybrid Cloud Strategy

Aiming to equip us with different types of infrastructure between Public Cloud, Private Cloud, and On-Premises.

Numerical Simulation Project
Context early 2021

Use cases:

- Engineers at CSTB are required to perform modeling and calculations in various areas of building and urban planning, which can involve large volumes and varieties of data, necessitating significant computational power.

- Examples: Finite element analysis for structural sizing, Wind load simulation (Notre-Dame de Paris), Climate models for long-term sizing of sensitive structures, Regulatory calculation engines, Real-time monitoring of physical tests, Smoke propagation, Fire resistance of materials, etc.

Type of calculations:

- Commercial software (Ansys, MSC, Physibel, Hydrus, etc.) or open source (Saturne, OpenFOAM, etc.)

- Execution on Workstations or HPC clusters

Assessment of Digital Simulation Offerings at CSTB:

- Governance: Tools and infrastructures are managed directly by business units

- Governance: Lack of inventory and service offering catalog

- Obsolescence: Workstations not integrated into the Information System and aging HPC Clusters

- Expertise: Lack of skills to operate these infrastructures

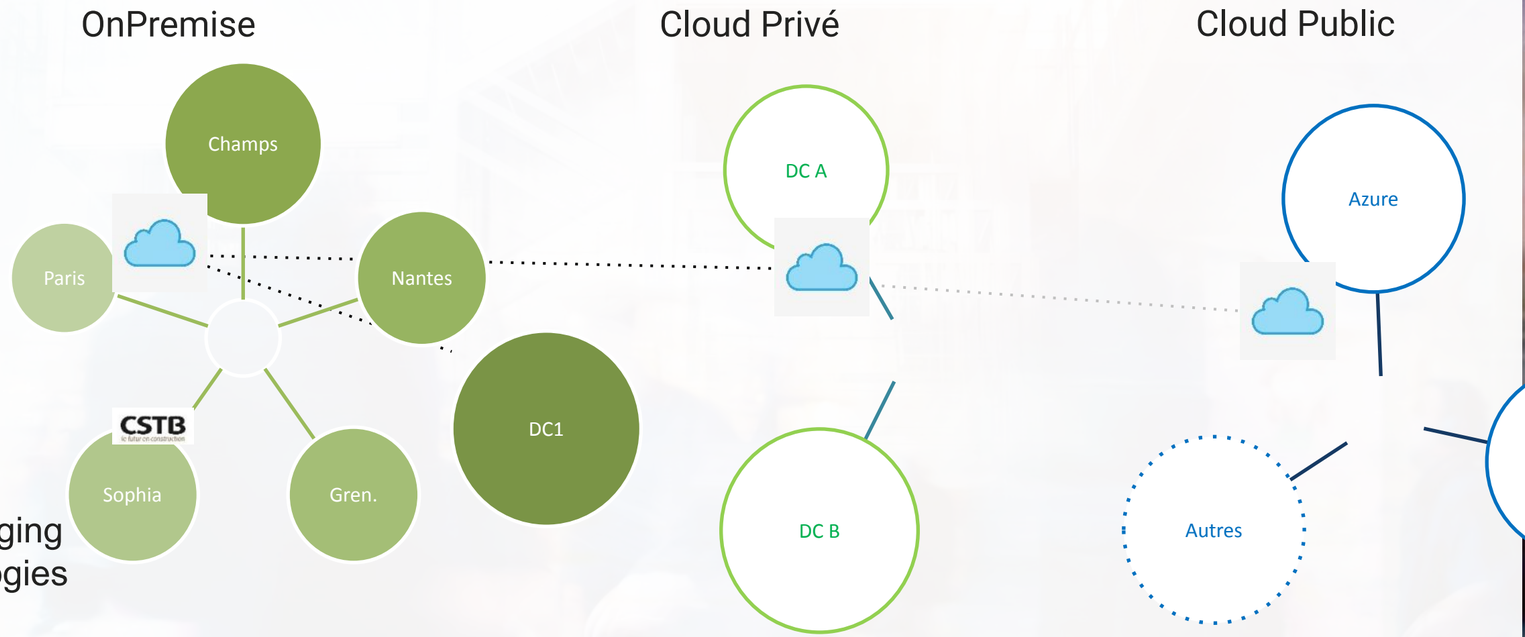
Numerical Simulation Project
Positioning in our Hybrid Cloud Strategy

Two experiments on Public Clouds launched in 2021

- HPC + Slurm + FDS AWS
- Climate/Wind Tunnel Simulation AZURE

Why Public Cloud ?

- Lower initial investment
- Resource availability
- Flexibility / Scalability
- Ease of addressing MCO
- Maintening performance over time
- Expanding the DSI's technology catalog: leveraging innovation through access to the latest technologies



Goals of the 2 POCs:

- Evaluate the support and compatibility of Public Cloud to meet CSTB's expectations
- Assess the budgetary aspect
- Evaluate the integration of tools with CSTB's Information System
- Remain agnostic of Cloud Providers
- Capitalize on the skills already acquired on simulation tools known by our experts

Numerical Simulation Project
Challenges to overcome

Type of calculations and needs:

- Latency
- Codes exécution time
- Cost management
- Appropriate storage solution

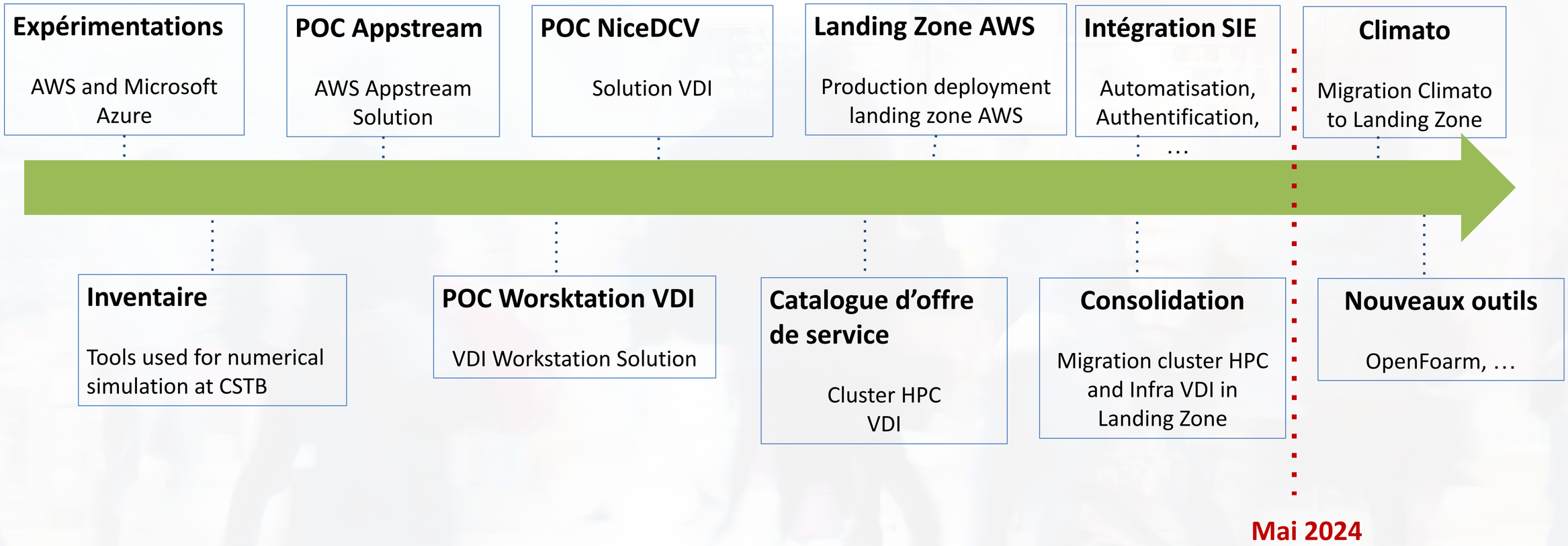
Aligning the final experience with user expectations

- Different user communities, software, usage
- Choice of Cluster / VDI / AppStream

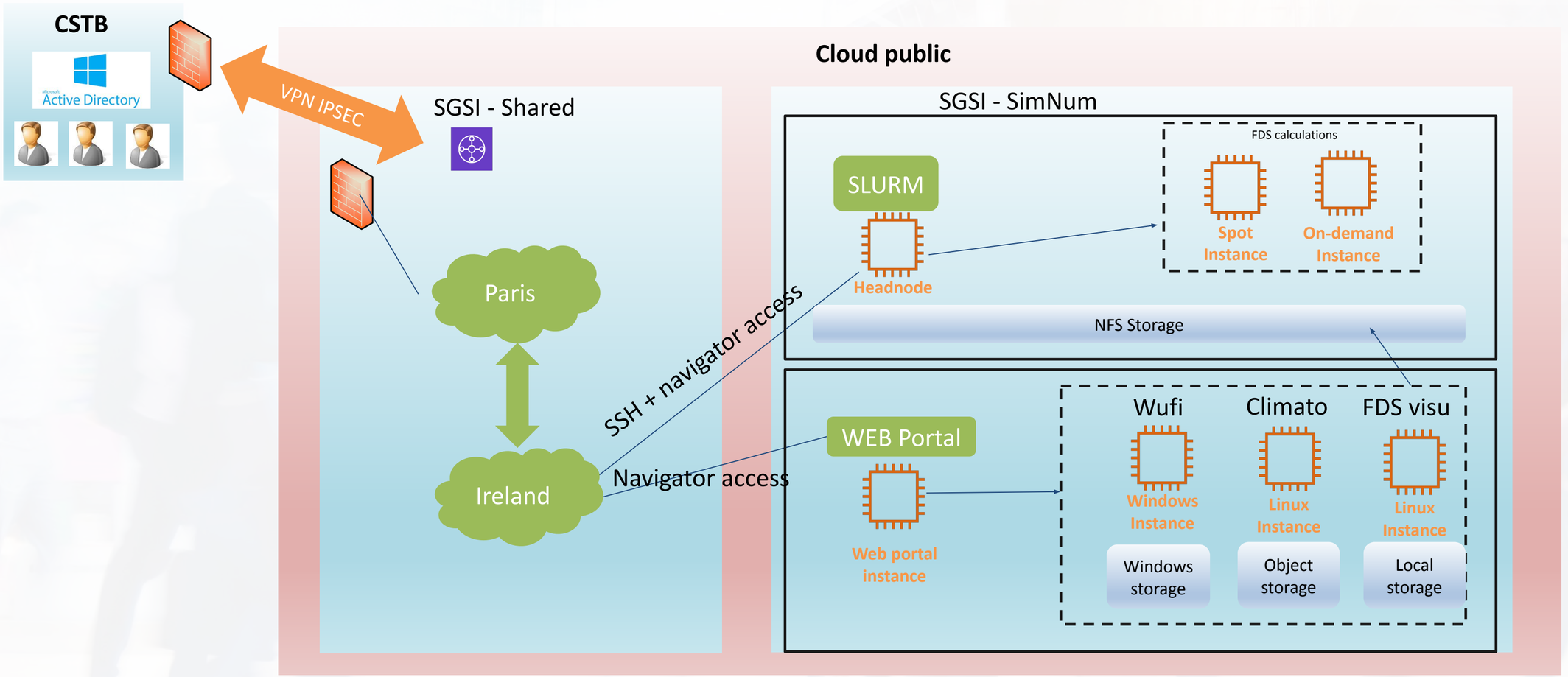
Integration into the CSTB infrastructure

- Active Directory
- Licensing
- Security
- Cost allocation method
- Automatisation - Infrastructure as Code deployed from CSTB CI/CD
  - Cluster HPC
  - VDI (Virtual Desktop Infrastructure)

Numerical Simulation Project
An iterative and use case-based approach



Numerical Simulation Project
Architecture



Numerical Simulation Project
Service catalog

1 – HPC Linux Compute Cluster (AWS ParallelCluster)

- Running parallel computing codes (MPI, OpenMP, GPU) via the SLURM scheduler
  Exemples de logiciel: FDS, Ansys, OpenFoam, Code_aster, Code Saturne, Solène, ...
- Use of the Linux command line

2 – Remote Desktop (VDI) Windows or Linux (NiceDCV)

- Graphical interface for high-performance visualization (meshing, post-processing, ...)
- Compute station for dedicated or non-dedicated code development
- Execution of non-HPC codes
- Option for physical license key
  Exemples de logiciel: Wufi, Hydrus, Physibel, …

3 – Local Machines

- Local environment (outside the Cloud)
- Data storage outside DataLake

Numerical Simulation Project
CSTB Feedback

Expertise and Support

- The importance of good support (Cloud Provider and Partner)
- Strong expertise in digital simulation from project stakeholders
- Flexibility to engage in an iterative approach to fully grasp the complexity of the subject
- Shared responsibility model: frees us from infrastructure maintenance, ...
- Integration challenge with Information Systems and asset lifecycle management

Difficulty in assessing business needs

- Team competence grows over the project's duration
- Challenges in evaluating tool sizing and usage
- Revision of non-cloud-compatible license contracts
- Team availability and project adaptation to production constraints

Data protection and security issues

- Contracting through our Hybrid Cloud partner
- Technical measures: default encryption implementation in the Landing Zone, access controls, data localization (Paris and Ireland)
- Hosting architecture in which administrators do not have access to our data
- Use of non-contextualized data for physical quantities, no personal or sensitive data

Evolution of the economic model

- Billing based on usage and consumption for departments
- Inclusion of maintenance costs in the economic model
- Finops challenges (spot infrastructure, usage-based billing, resource reservation, ...)

Numerical Simulation Project
AS+ Feedback

Flexibility

- Opportunity to test numerous solutions
  - Wide range of instances (performance)
  - Wide choice of services, "managed" or not, with different strengths and weaknesses that can address various use cases

Availability and speed:

- Resources immediately available
- Preliminary tests possible within a few hours

Integration:

- Easy connection to CSTB infrastructure via VPN
- Integration with AD
- IAC : Effective and well-documented API/CDK allowing fine control of deployments

Difficulty in identifying the best solution

- Very wide service offering
- Finding the best compromise between performance, deployment cost, maintainability, and user comfort

Mastery of components and costs

- Requires an understanding of Cloud operation mode (managed services, assembly of Cloud components)
- Requires attention to cost considerations from the design stage of the envisioned architecture

Outlook for the Future

Consolidation of all CSTB tools into the service offering

- Industrialization of the offering
- Discontinuation of obsolete infrastructures and integration into the “Numerical Simulation" catalog

Optimization of the "Digital Simulation" infrastructure

- Implementation of a portal to facilitate the execution of calculation codes

Facilitating access to innovation for other use cases, accessibility of new technologies

- Challenges of experimentation around augmented reality, digital twins, ... for our future projects
- Preparation for the "Innovation Day" for internal CSTB teams to promote innovation acceleration

AS+:

- Reproducible VDI and HPC Cluster deployment approach and workflow
- Leveraging the skills development of engineers in the field of Infrastructure as Code (IaC) deployment to build other cloud infrastructures for our clients