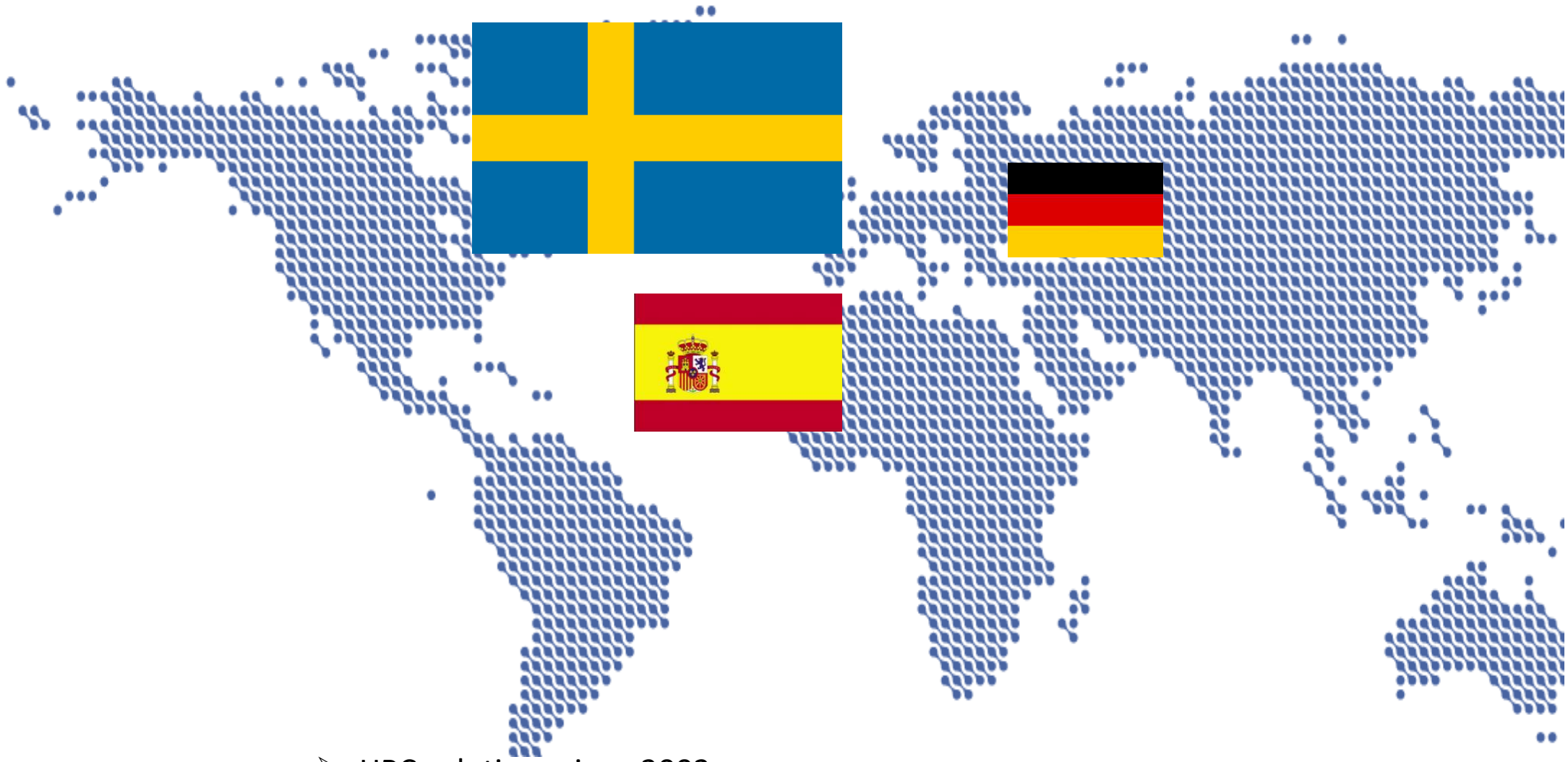# Transitioning LS-Dyna workloads to the Cloud in the path to Digital Maturity

NORDIC LS-DYNA USER CONFERENCE, GOTHENBURG

October 2022

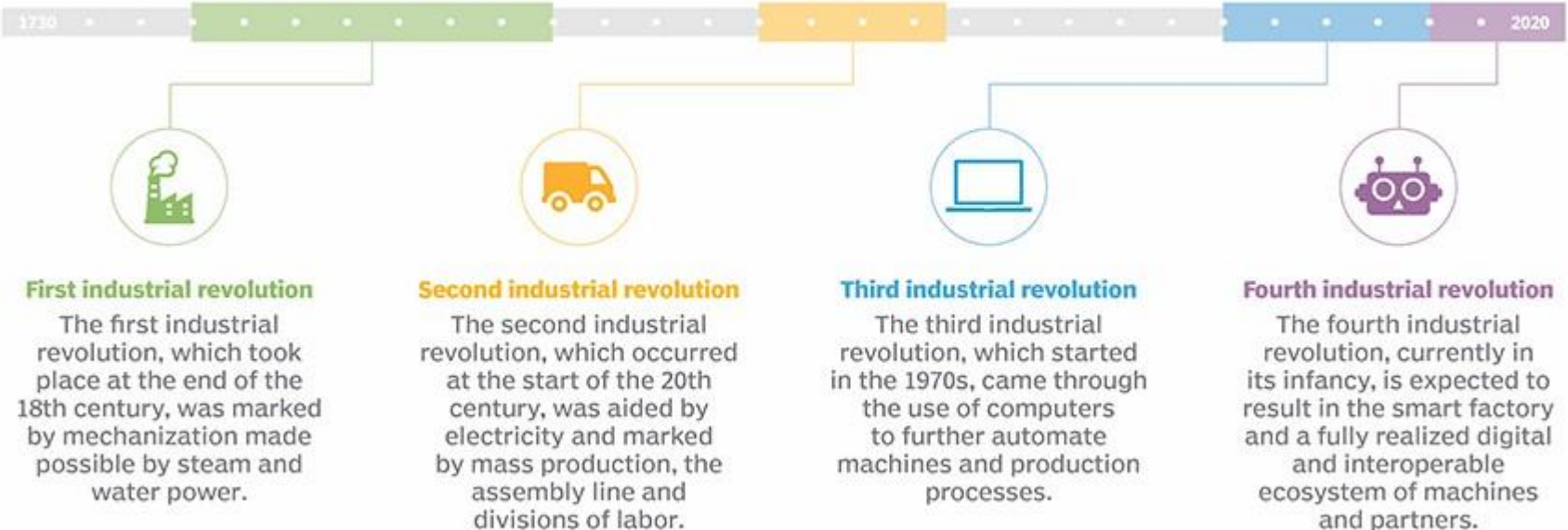Manuel López-Quiroga Teixeiro
mqt@gompute.com

- HPC solutions since 2002
- CAE customers
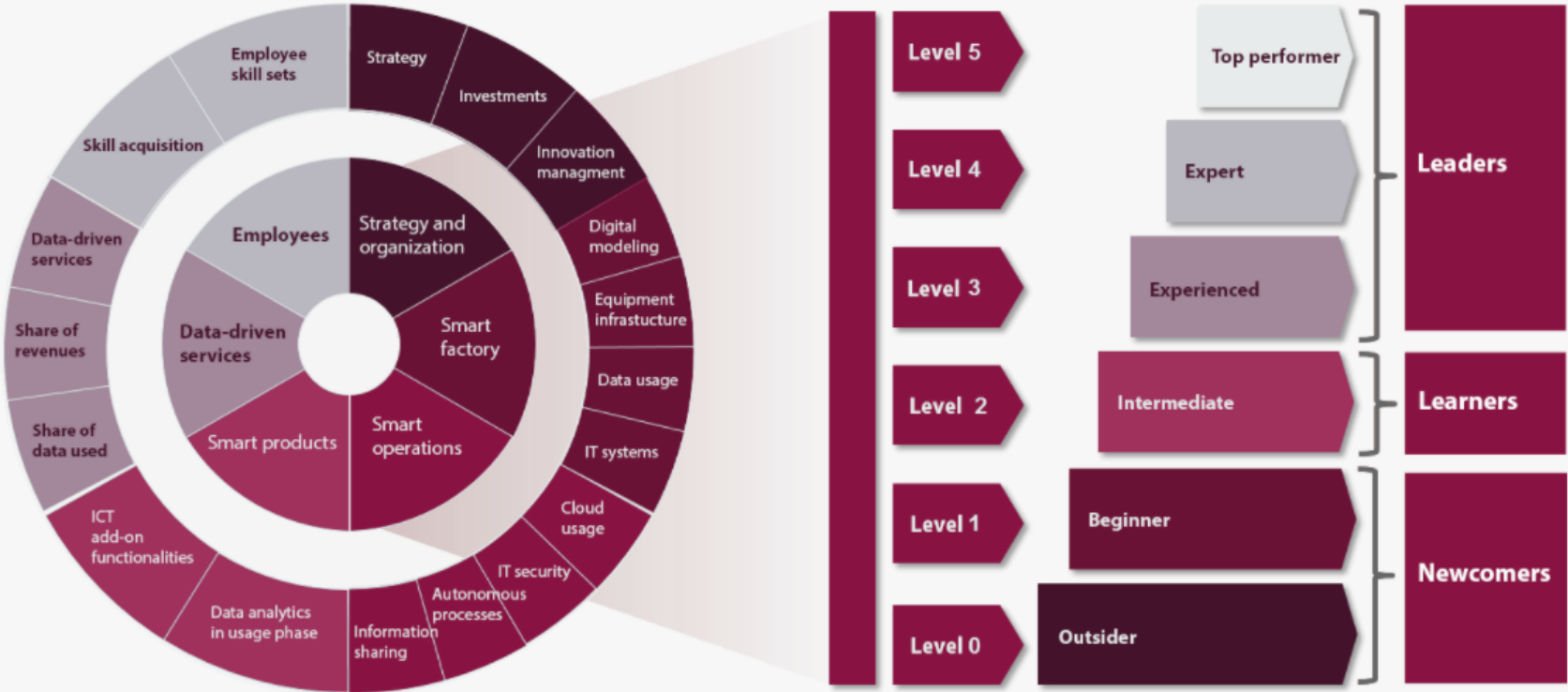- Multiple industries: marine, automotive, energy, manufacturing…

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Industrial revolutions

First industrial revolution
The first industrial revolution, which took place at the end of the 18th century, was marked by mechanization made possible by steam and water power.

Second industrial revolution
The second industrial revolution, which occurred at the start of the 20th century, was aided by electricity and marked by mass production, the assembly line and divisions of labor.

Third industrial revolution
The third industrial revolution, which started in the 1970s, came through the use of computers to further automate machines and production processes.

Fourth industrial revolution
The fourth industrial revolution, currently in its infancy, is expected to result in the smart factory and a fully realized digital and interoperable ecosystem of machines and partners.

The 'Industry 4.0 Readiness' study was commissioned by the IMPULS Foundation of the German Engineering Federation (VDMA) and conducted by IW Consult (a subsidiary of the Cologne Institute for Economic Research) and the Institute for Industrial Management (FIR) at RWTH Aachen University.
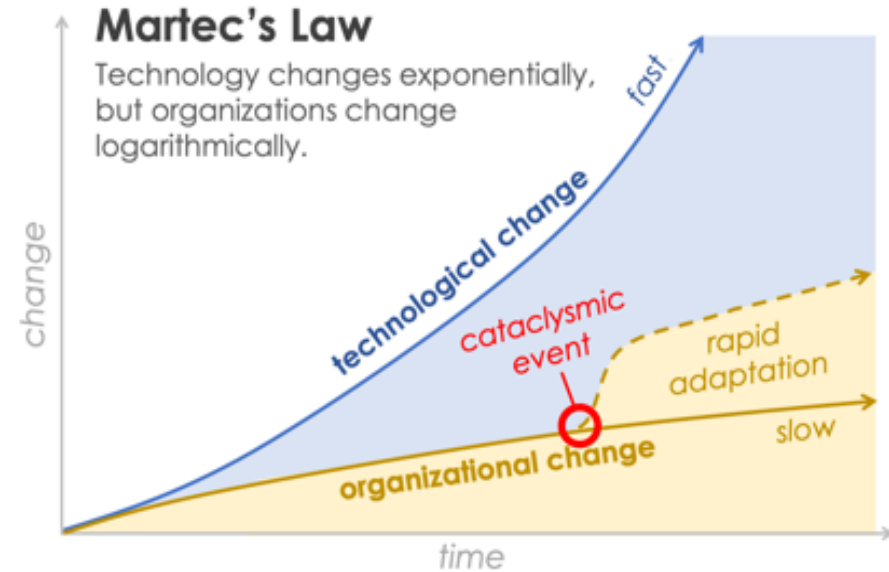
Traditional, M&A created companies have more difficulties to change than technology based / Startups

These companies are subject to Martec´s law – an ever-widening gap that requires eventually to reset

Cloud models available

- Cloud is installed on internal company systems, centralized on one or few sites.

In-house / Enterprise cloud

- An in-house cloud complemented with a private or Public cloud

Hybrid Cloud

- HPC resources are located on a certain datacenter, with exclusive use of the enterprise during the contract period

Private Cloud

- General access cloud resources, mounted on multi-location providers.

Public Cloud

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Cloud models: Decision Drivers

Data Location
- Company policies or end customer restriction might force enterprises to run in-house

Budgetary structure
- Specially on large enterprises with subsidiaries managed by OPEX and CAPEX, owning hardware or part of it could be a requirement. A private cloud option sometimes fits, as all costs can be pre-defined.

Management of internal resources
- When an IT team is not available, external resources (private or public cloud) are a more viable option
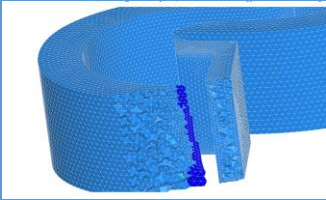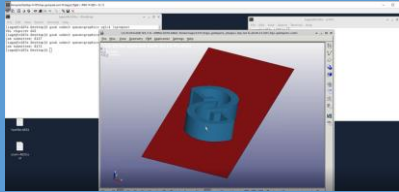
Fluctuating needs:
- For those enterprises working per-project with a variable workload, there is a clear adaptation to pure cloud models.

Electricity and hosting infrastructure:
- When the use of simulation grows, more space and power is needed. Allocating a space for this is not an option on certain locations, forcing companies to go for a private or Public cloud.

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Workflow	Pre-processing	Solving	Post-processing	Details
Pure Cloud	Cloud	Cloud	Cloud	Support for multiple pre-post processors required.
Hybrid	Local	Cloud	local	More data transfer required

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➤ Generation of the architecture: Vendors have different architectures available, that must be evaluated. A discounted price on a previous generation can offer the users to get more cores within a certain budget, sometimes sacrificing a small percentage in performance per core

➤ Number of cores per node: The scalability and model sizes need to be evaluated in different architectures, always checking the license restrictions

➤ Virtualization or bare-metal nodes: Virtualization might affect final simulation performance, so a bare-metal configuration is always preferred

➤ Interconnect: When running multi-node, a fast interconnect is required in order to keep the scalability

➤ Tuning: The installation and configuration needs to be tested and adjusted for a certain hardware type in order to get maximum performance

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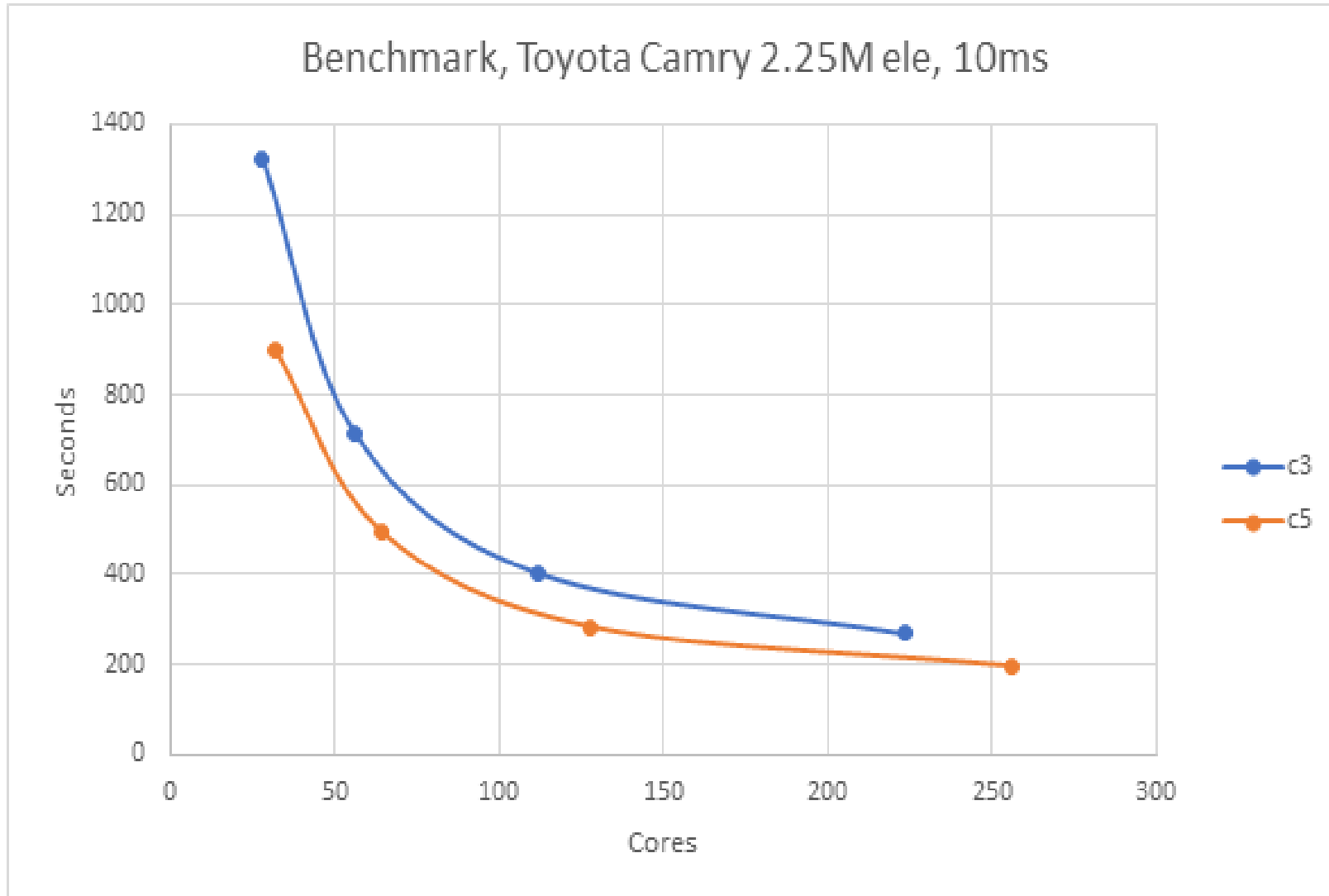
Benchmark representation on C3 nodes (Intel E5-2680v4) and C5 nodes (Intel Gold 6242)

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Connectivity Options

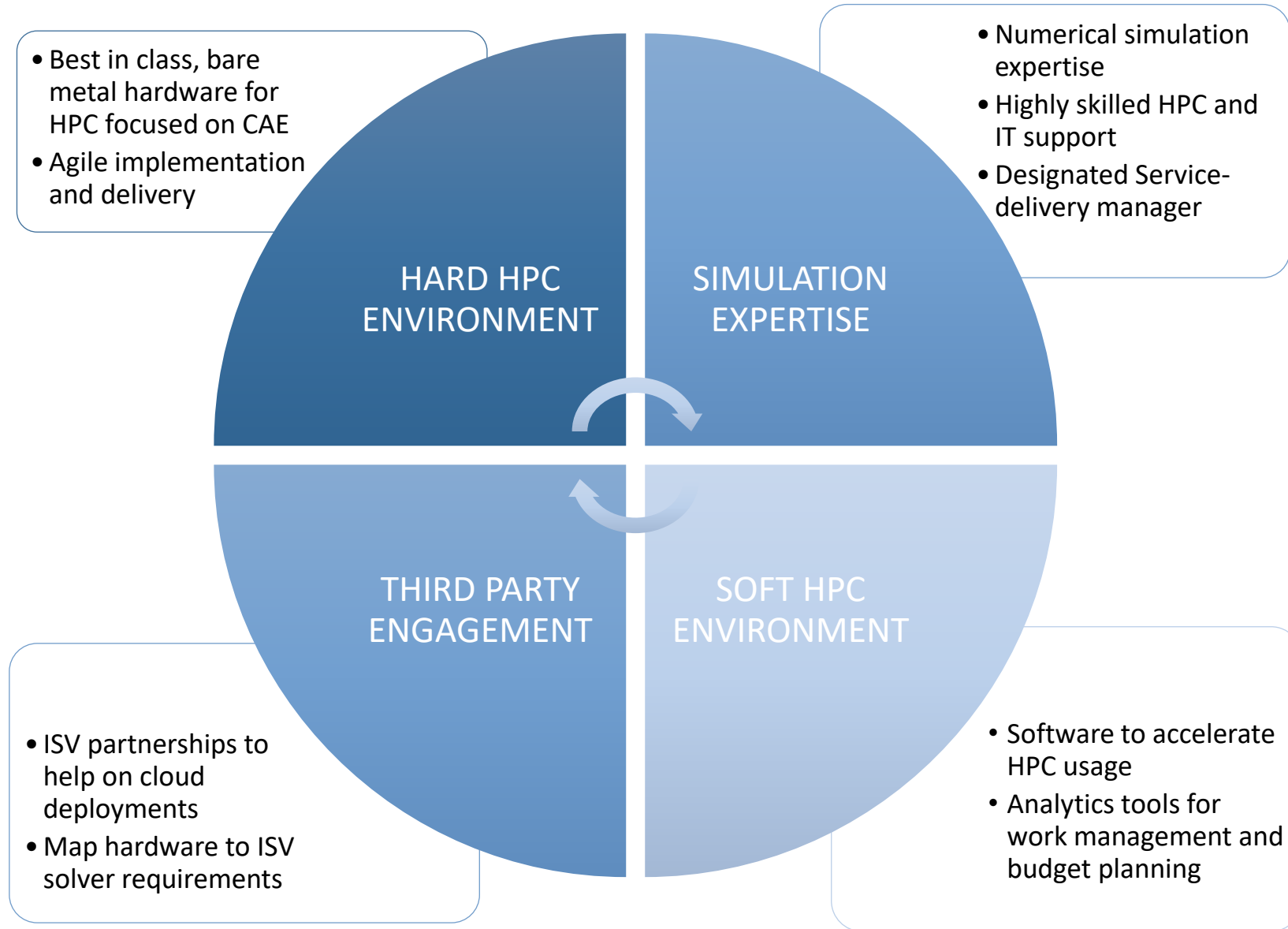| Direct	IP-Restricted	VPN	Private Line
• Access is available over the internet.	• Only certain IPs can access the service. For users on home-office a static IP is required.	• Customer enterprise is connected to the resources on a VPN. Users working from home need a VPN to their company to access the service.	• Customer is accessing the service directly. Is the best-performing solution, price depends on distance to the data center

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In-house license server(s) per site

Cloud based license server(s)

Global (internal) license server

AEU / On-demand

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Summary: Four pillars

- Best in class, bare metal hardware for HPC focused on CAE
- Agile implementation and delivery

- Numerical simulation expertise
- Highly skilled HPC and IT support
- Designated Service-delivery manager

HARD HPC ENVIRONMENT

SIMULATION EXPERTISE

THIRD PARTY ENGAGEMENT

SOFT HPC ENVIRONMENT

- ISV partnerships to help on cloud deployments
- Map hardware to ISV solver requirements

- Software to accelerate HPC usage
- Analytics tools for work management and budget planning

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[1]   Aslanova, I.V., Kulichkina, A.I. (2020): "Digital Maturity, Definition and Model", Advances in Economics, Business and Management Research, volume 138

[2]   Brinker, S. "Martec's Law: Technology Changes Exponentially, Organizations Change Logarithmically." Chief Marketing Technologist (blog), June 13,
(2013). https://chiefmartec.com/2013/06/martecs-law-technology-changes-exponentially-organizations-change-logarithmically/

[3]   Kupilas, K., Montequín, V. & Álvarez-Pérez, C. & Balsera, J (2021). Industry 4.0 and Digital Maturity, Chapter 2.

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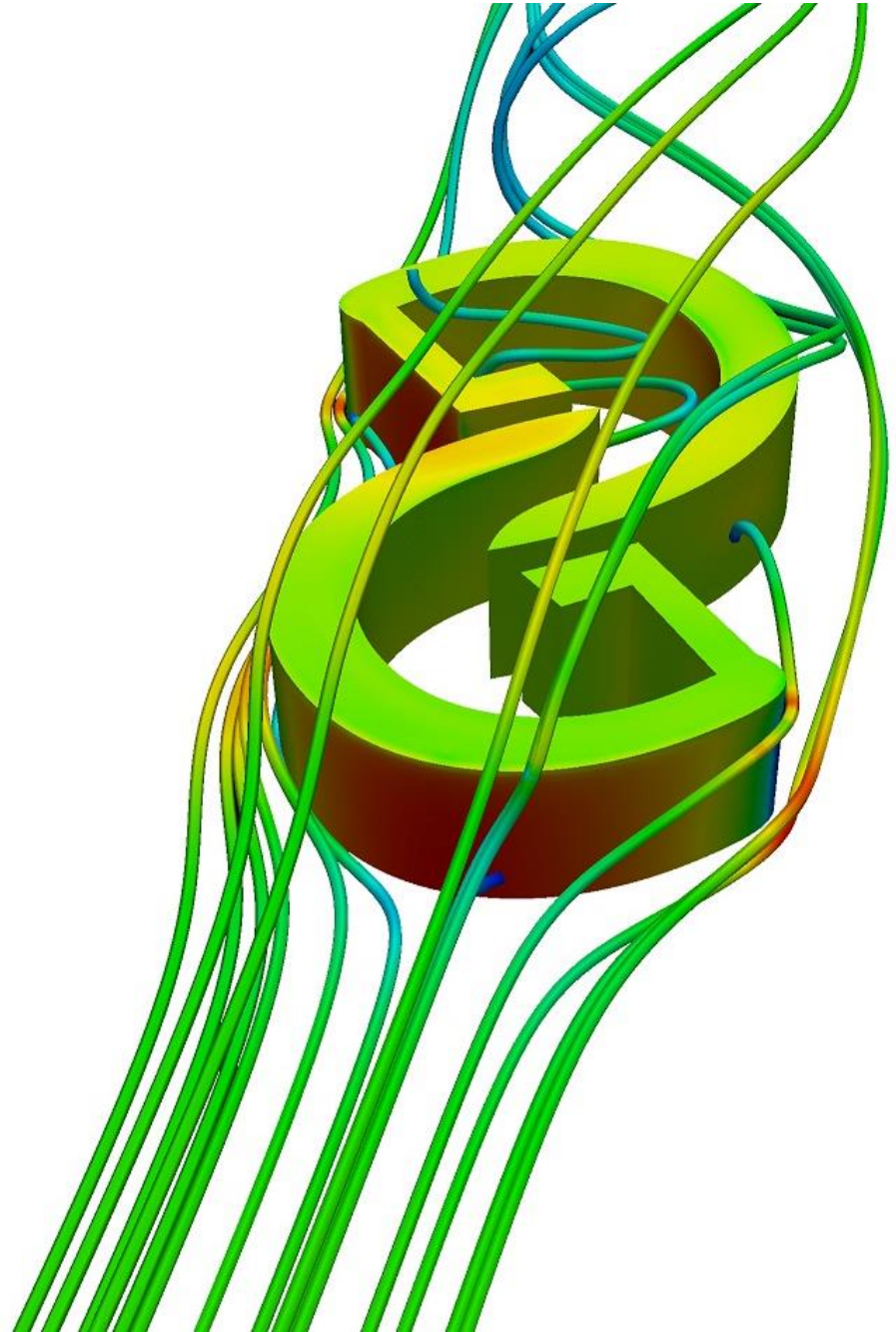
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