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

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Abstract

Industries worldwide are going through a Digitalization process towards industry 4.0 where cloud resources play a key role, forcing a transition for CAE engineers from traditional, in-house HPC to more flexible solutions in the cloud.

On the digital maturity journey there are different dimensions to consider when transitioning a CAE team to the cloud as a permanent solution, being the needs and requirements of the different industries not always covered with a single solution, what requires an analysis of the different layers involved (IT/Network, Licensing, Security, Engineering).

Firstly, the Gompute team will cover an overview of the different options available in the market, and how those can be deployed for LS-Dyna users based on their needs. Secondly, the most important dimensions that any corporation will require on this transition: Performance and Security, for what Gompute will show the scalability results of LS-Dyna on different hardware types, and the most common set-ups to guarantee data protection both from on-premise or home offices.

1 Digital Maturity, Digital transformation and Cloud adoption

In order to define the role of Cloud adoption, we need to define what is “Digital Maturity”. There is not a single definition on the literature, but a common root in most of them is: “ The capacity of an organization to adopt and take advantage of the digital technologies available”. Digital transformation, as part of the path to achieve Digital Maturity, is defined as “the application and use of modern technologies in the organization’s business processes to achieve its goals and increase efficiency“ [1].

1.1 Company nature

As defined in Martec´s law, technology advances exponentially (Moore´s law) while organizations change logarithmically. This is setting up a challenge for organizations to absorb changes, so the gap trend to widen over time, and sometimes a organization “reset” is required, making it a complex process to achieve Digital Maturity [2].

Digitalization is just on the roots of any Startup or young company, being part of the company culture, while for multi-cultural companies operating over decades this is not a trivial task, with difficulties being directly proportional to the level of complexity of the organization, specially on large conglomerates result of merges and acquisitions, carrying legacy thinking and behavior, where implementing a digital transformation strategy adoption requires a special planning with longer timeframes than any smaller or homogeneous entity [3].

Any cataclysm event like the 2020 COVID-19 crises has speed-up digital transformation in most corporations, removing lots of barriers (budgetary, bureaucracy, time…) and becoming a priority in the general management agendas.

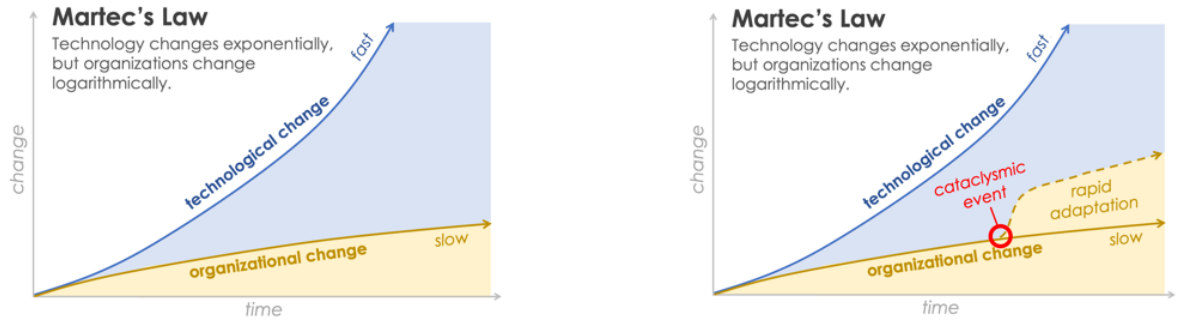

Fig.1: Martec´s Law representation. On the right, including a cataclysmic event like the COVID-19 Pandemic. Source: Brinker S.

1.2 Cloud adoption

Cloud adoption is just a small part of the digital maturity journey of any organization, but a challenge for those Engineers that need to move CAE workloads. A real High-performance computing solution is required in order to reduce total simulation time and make the most out of the pre-invested software licenses.

When talking about HPC for CAE, different cloud models are available in the market, in order to fit the different company types. The alternatives can be classified based on different criteria, being the location of the resources the most common one. HPC cloud for CAE can be divided then in 4 main blocks:

In-house / Enterprise cloud	**Hybrid cloud**	**Private cloud**	**Public cloud**
Cloud is mounted on internal company systems, centralized on one or few sites.	An in-house cloud complemented with a private or Public cloud	HPC resources are located on a certain datacenter, with exclusive use of the enterprise during the contract period	General access cloud resources, mounted on multi-location providers.

Table 1: HPC Cloud types based on hardware location.

When moving to one of the options listed in Table 1, there are different criteria to choose one of the options in the list, summarizing:

- Data location: Company policies or end customer restriction might force enterprises to run in-house.
- Ownership and data manegement: Due to project or NDA regulations, in these cases Public cloud is not an option.
- 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 look like a more viable option.
- 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.
- Fluctuating needs: For those enterprises working per-project with a variable workload, there is a clear adaptation to pure cloud models.

As can be seen, several of the above listed options depend on legal or administrative requirements. During the last years and thanks to the pandemic push, there is a trend to change rules and make the move to the cloud easier for the end users.

2 Moving LS-DYNA loads to the cloud

There are 2 main decisions to take when moving the local simulations to any of the defined cloud options:

2.1 Performance

Performance of the simulation can be defined by the total time a simulation takes compared to a previous workflow (engineering performance), or the total elapsed time on the simulation run. In the first, the capacity of remote pre-post processing is key, so users just need to upload a CAD file and then the whole mesh can be created in the cloud.

For simulation performance of LS-DYNA, the next criteria need to be evaluated when choosing a certain hardware:

- 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.

Users must note that there is always a price driver on the decision making, so price-performance is one of the measuring units when evaluating a certain option.

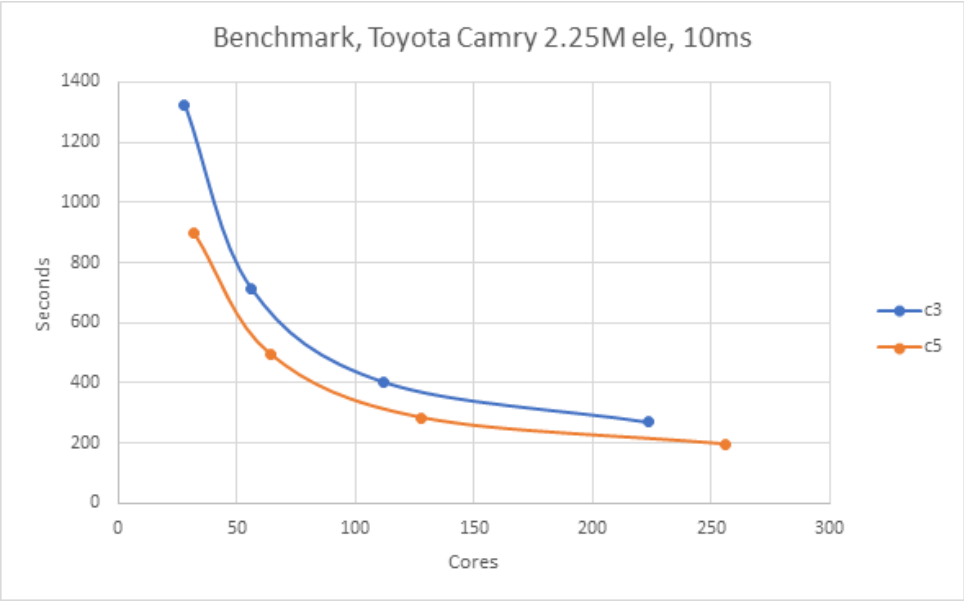

Fig.2: Benchmark representation on C3 nodes (Intel E5-2680v4) and C5 nodes (Intel Gold 6242).

2.2 Security and connectivity

Nowadays many psychological barriers on the cloud being insecure have been removed, and providers have options that can be customized to be an extension of the enterprise internal IT. In those cases where sensitive data is managed, having a dedicated file server is a preferred option, then a private cloud is usually a preference over a public cloud.

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.

Table 2: Connectivity options.

From the connection options, nowadays having a private line is becoming a popular solution when there is a decent amount of users, and the solution is available for a mid-long term due to the initial installation costs.

LS-DYNA requires a license to run, so the connection of a license server must be evaluated. Cloud hosting partners are allowed to host also the license on a cloud license server, but when users prefer to have a local license server installation, is required a stable connection to the cloud service.

3 Summary

Nature of the enterprise will be a key decision maker on the cloud model chosen, but in all cases a true HPC system is required when moving LS-DYNA workloads. Having remote visualization is a plus, as reduces the amount of data transferred, and opens the possibility to eliminate local storage of simulation databases, more than regular input files for back-up.

4 Literature

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

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