Scaling LS-DYNA on Rescale – HPC Cloud Simulation Platform

Joris Poort, President & CEO, Rescale, Inc.

Ilea Graedel, Manager, Rescale, Inc.

1 Cloud HPC on the Rise

1.1 Background

Engineering and science simulations demand an increasing amount of computing resources. The majority of those resources consist of high performance computing (HPC) hardware, which are adaptable and highly efficient for running simulation software. Enterprises strive to create a lean and agile IT structure that both meets the current and unanticipated future needs of the various internal teams—without creating a cost structure that is unsustainable or disconnected from justifiable activities.

1.2 HPC and Cloud HPC Trends

HPC is on the rise. The overall market for HPC is estimated to grow at a rate between 6.8-7.8% globally, through the year 2016. Along with increased HPC use has come the increased use of cloud HPC. It continues to achieve steady growth alongside the booming HPC market. The general HPC sector is estimated to grow to $33.4 billion by 2018—up from $21.9 billion in 2012. Cloud HPC is the fastest growing sector in the general HPC as both a complement and replacement for traditional on-premise HPC. A recent Gartner study of CIOs found that almost half "have shifted their priorities from cloud as a concept to a viable option".

Another report from SAP and Oxford Economics found that over 80% of enterprise IT said that, within three years, they expect Innovation and R&D work to be using cloud services. Roughly 50% of those surveyed use cloud platforms to "manage and analyze big data, anytime and anywhere". The participants in this survey were CIOs, CEOs, IT managers, and developers. Over 70% are looking to significantly invest in cloud resources moving forward. These cloud resources are being used to collaborate more efficiently, develop new products, expand business, and better structure existing networks.

With more enterprise companies shifting to cloud-based resources, an important component is selecting appropriate tools to optimize engineering and science workflows.

2 Rescale: Cloud Simulation Platform

Rescale is the leading, globally located, highly secure cloud simulation platform specifically designed for computer-aided engineering (CAE) analyses. With a focus on high performance computing (HPC), Rescale provides an innovative solution for enterprise companies to seamlessly execute complex simulations, instantly from anywhere in the world. Lengthy procurement cycles are eliminated, operating and capital expenses are drastically reduced, and engineering and science needs are instantly met.

Unlike other solutions, Rescale's platform is purely on demand. There are no job queues and large-scale capacity is immediately configurable for simulations ranging from finite element analysis to computational fluid dynamics to bio sequencing to oil reservoir mapping. With over thirty global data centers, Rescale supports the largest, high security HPC infrastructure footprint available commercially. The versatile finite element analysis tool, LS-DYNA is natively integrated into Rescale's

platform. Collaborative engineering and science tools are centrally located and significantly improve product design cycles while reducing expenses and turnaround times.

3 How to Run LS-DYNA Simulation on Rescale's Cloud Simulation Platform

3.1   Rescale Cloud Simulation Platform Account

Users access the Rescale cloud simulation platform by creating an account and either using Rescale's intuitive web-based platform or the Rescale application program interface (API). Once logged into their account, users will see a list of any jobs they have ever saved or executed and any jobs that have ever been shared with them.

Fig.1:   Rescale user dashboard

In the top left corner, users select the +New Job button to launch the setup window for a new simulation. Now users have the opportunity to view their entire workflow process as well as change the type of job they'd like to run. Rescale users can run single-run LS-DYNA jobs or perform advanced analyses such as design of experiments (DOE), Monte Carlo analyses, and optimizations, among others. The first step in setting up any job is uploading input files.

Fig.2:   LS-DYNA setup page

3.2   LS-DYNA Simulation Setup Using Rescale's Platform

Once the LS-DYNA model has been constructed using LS Pre/Post, users save their input files and upload them to their Rescale account. To ensure security, Rescale's file transfer system encrypts data client-side before sending it through an encrypted channel. Using Rescale's enhanced file transfer manager, users can upload multi-threaded files through a fully saturated bandwidth connection.

The next phase in setting up a single run job is to select the LS-DYNA software. Once the LS-DYNA simulation software is selected, users have the option to choose the version they'd like to run. Here is where they also specify the license model they'd like to use. The command line prompts users for the information to enter and ultimately executes the run based on the file and hardware configuration the user chooses.
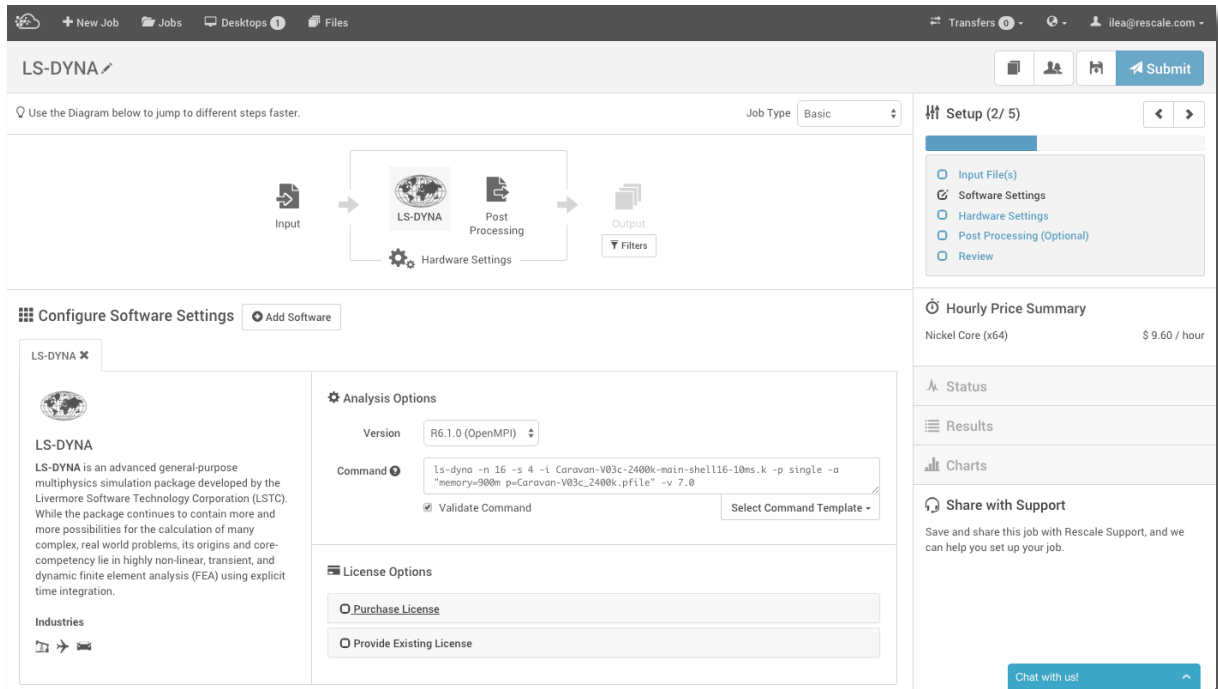
Fig.3: *LS-DYNA software selection*

Rescale partners with external data centers around the world to offer enterprise companies access to hundreds of thousand of HPC cores instantly. Data centers are located throughout North and South America, Europe, and Asia. Using the interface, users choose the hardware best suited for every simulation from an extensive list that includes standard CPUs, HPC, InfiniBand connection hardware, and GPUs, among others. Once the core type is selected, users scale out the hardware as far as needed.
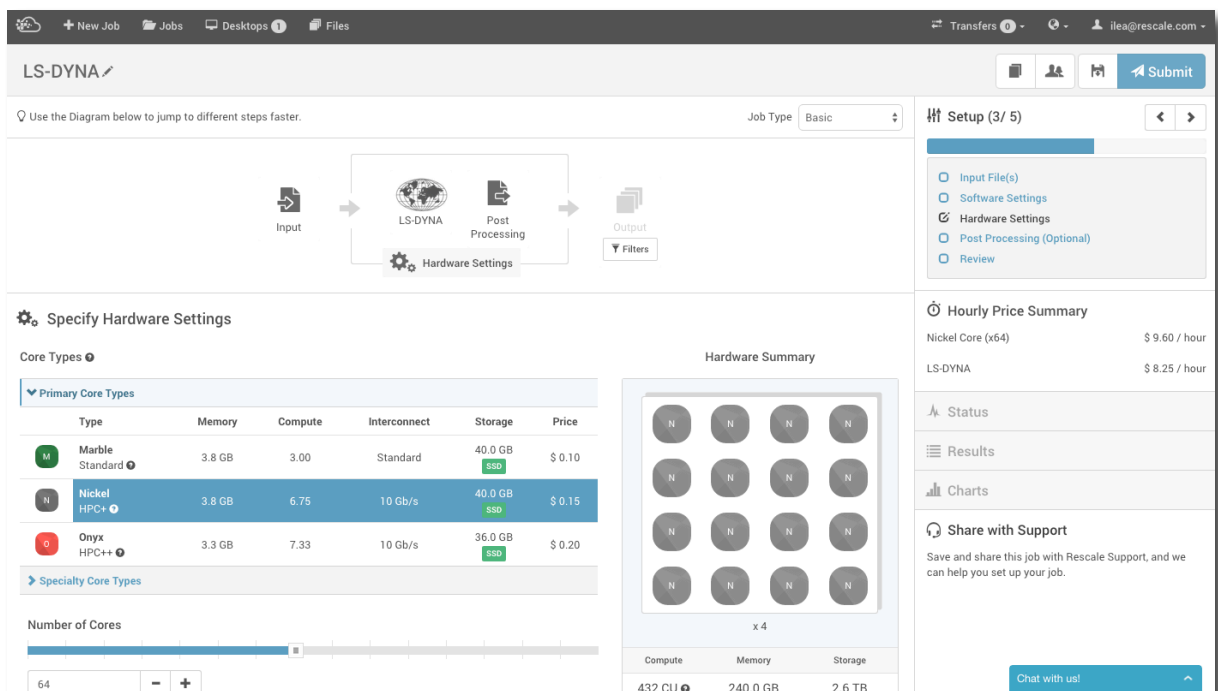

Fig.4: *Customize high performance computing (HPC) hardware*

Post-processing for initial analysis is also available with Rescale. Users upload custom scripts in the same way they would input files. More advanced post-processing capabilities including remote

visualization and remote cluster access are also available to engineering and science teams directly through Rescale's platform.

After a quick review of the overall setup, users can either save or immediately submit their custom-configured LS-DYNA.

3.3 Monitoring LS-DYNA Simulation Progress in the Cloud

Once the simulation is submitted, users can monitor job progress on the Status page. It takes approximately five minutes to provision the customized HPC hardware and then the LS-DYNA simulation will begin running. Once the job begins, users can monitor the progress of their job directly in the browser with the Live Tailing feature. Here users select an active run and then view any text, animation, or image files generated by the job. Other job and progress monitoring tools provide real time data on the status of the LS-DYNA simulation.
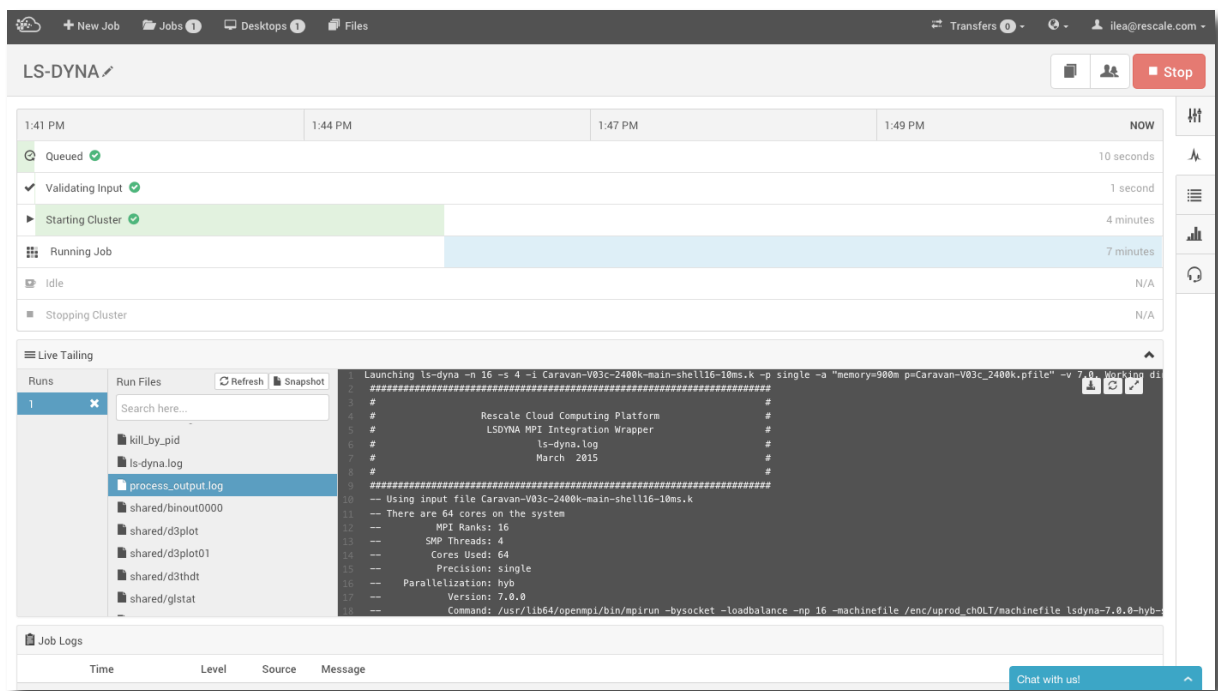

Fig.5: Monitor LS-DYNA simulation progress in real time

Should the simulation encounter an error, users have the power to shut down either an individual run or the entire job. Once the job and cluster are stopped, users can retrieve file information to further evaluate or modify their simulation.

3.4 Viewing and Managing LS-DYNA Output Data

In the Results section, users will see all the completed LS-DYNA runs and the associated output files. Mass action commands for downloading or deleting can be found here as well as individual file selection. Users never need to download all results files and can store them indefinitely in their Rescale platform account.
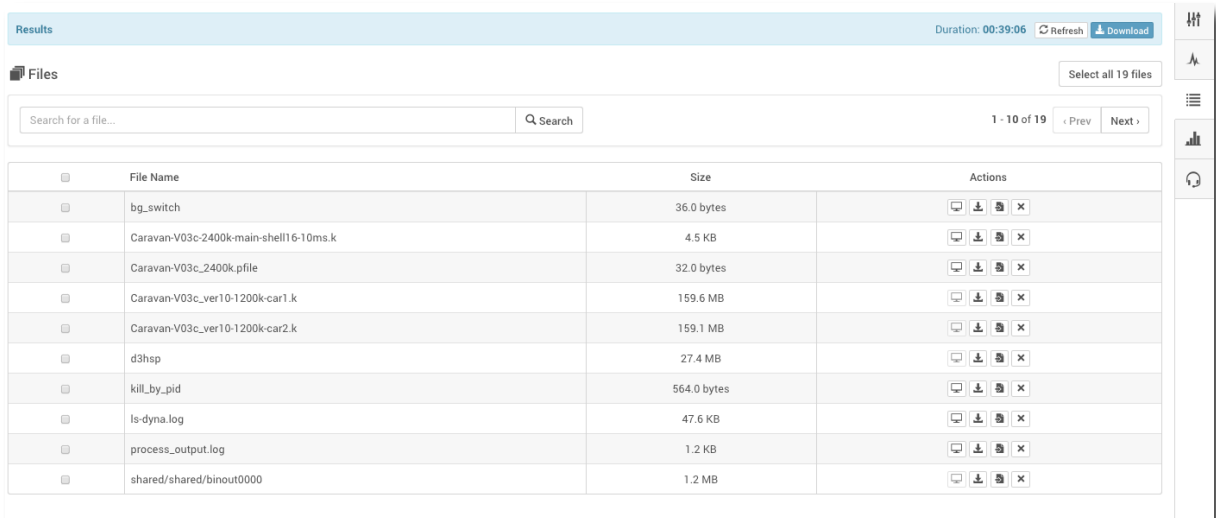
Fig.6:   *View results files directly in the browser*

Engineering and science simulations don't always execute properly and should an issue arise, users can securely share their simulation with Rescale's dedicated technical support team for troubleshooting. Live chat is enabled for immediate help with job setup.
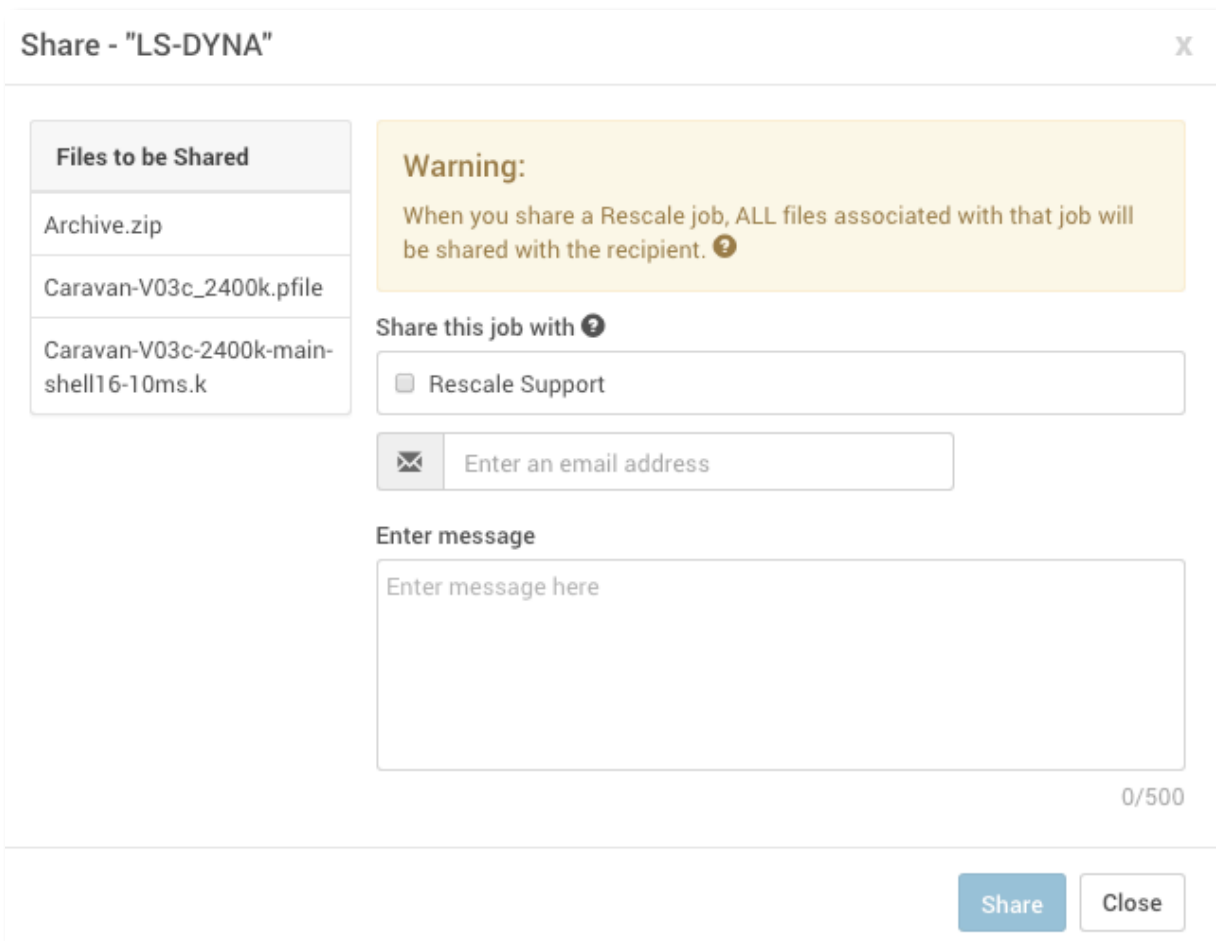

Fig.7:   *Share simulations with colleagues or Rescale technical support*

Running the analysis is only part of the challenge. Once the simulation is completed, engineers and scientists need to analyze their LS-DYNA results and make critical design and development decisions.

Often times, simulations generate very large output data. Downloading large files is not always a feasible option. Using Rescale's platform, LS-DYNA users can initiate Desktops, a remote desktop visualization tool. Through Desktops, users can run LS-DYNA Pre/Post directly in their browser and eliminate the need to transfer files from their Rescale account to their local machine.

3.5 Remote Visualization

Similar to creating a new job, users generate a new Desktops session by selecting whether they'd like to use a Windows or Linux machine.

Security is a key and important component to Rescale's cloud simulation platform. Apart from data encryption, private cluster isolation, kernel encryption, and annual security audits, Rescale promotes user security by enforcing strict security passwords. To generate a Desktops session, users must generate a new password for every new session they start.
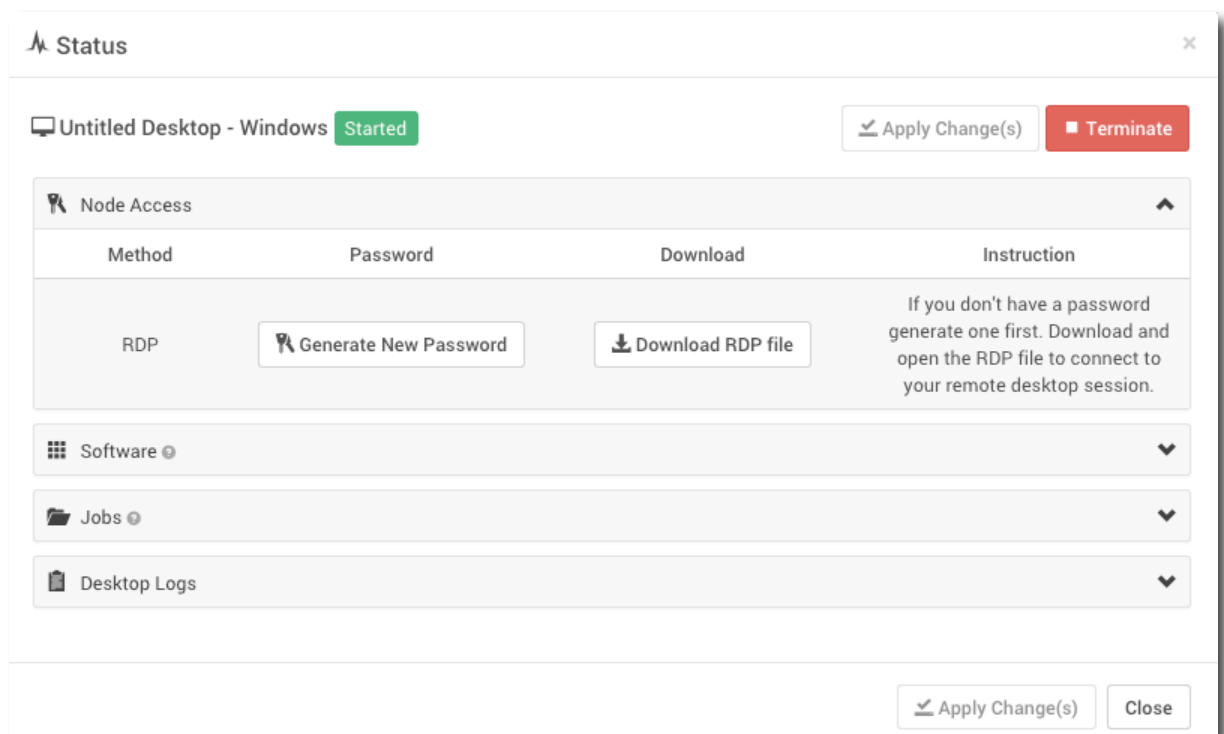
Fig.8: Windows Desktops session for LS-DYNA

Once a remote desktop session is activated, users can add the LS-DYNA Pre/Post tool and their active job to their session.

Fig.9:   LS-DYNA Pre/Post software in Desktops session

Once both the LS-DYNA Pre/Post software and the job have been added to the Desktops session, users can open the remote desktop, start LS-DYNA Pre/Post, open their simulation, and begin analyzing the results.

Fig.10: Remote visualization of LS-DYNA job using LS-DYNA Pre/Post from Rescale's platform

4 Security and Administrative Control

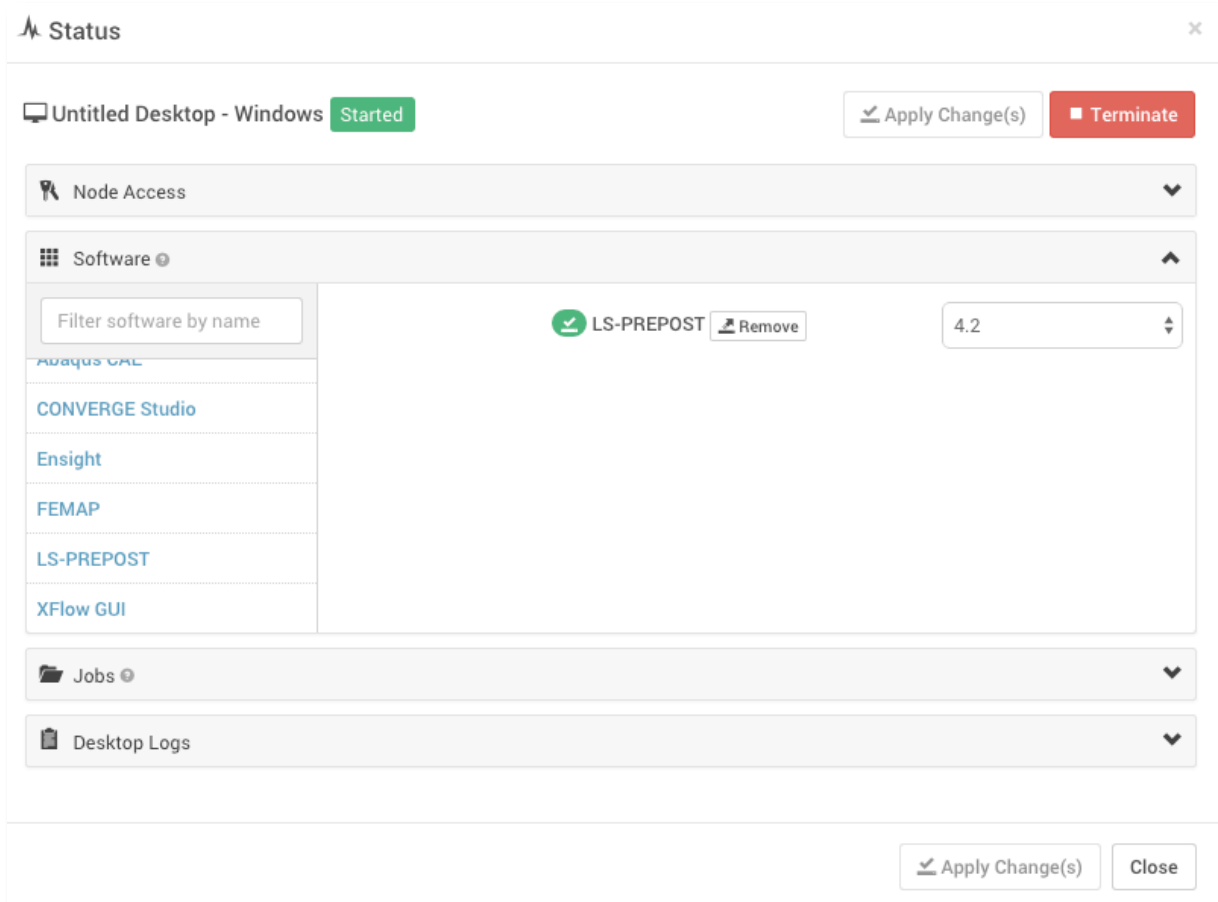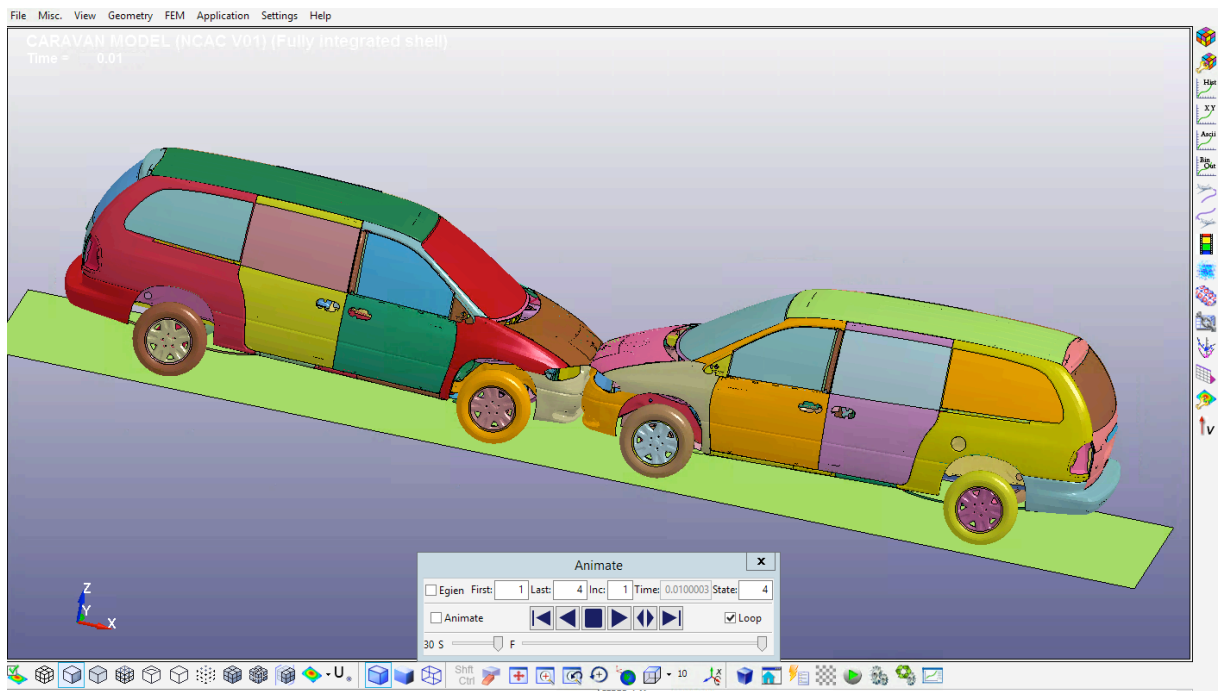The most common objection to adopting a cloud HPC environment immediately is that a company is not comfortable using outside IT resources due to the sensitivity of proprietary data. Security vulnerability is often higher in a closed system relying on a single layer of firewall protection compared to multi-layered security protections deployed in leading cloud HPC solutions with isolated networks, end-to-end data encryption, and data segmentation. Cloud HPC environments now have clear standards and policies, such as the SOC compliance standard, to allow enterprises the ability to easily identify compliant organizations.

Maintaining all simulation data on internal systems is becoming increasingly difficult and expensive. Staying abreast of evolving security vulnerabilities becomes more challenging. A cloud solution allows for a software-defined method of control and regulation by IT, rather than implementing policies that you expect and rely on employees to follow. By putting these programmatic controls in place, you reduce risk by narrowing the scope of access of a single individual while removing unnecessary barriers blocking collaboration between authorized users. For extended enterprises, these software defined controls and policies allow for better supplier management and limited collaboration with third parties. Rescale's cloud simulation platform can enable the capability to share LS-DYNA data seamlessly with suppliers without giving up access to internal networks.

In addition to industry-leading security features, enterprise administrators can activate, deploy, and manage the Rescale platform instantly for their organization and users via a web-based administration portal. Through this portal, administrators can easily manage and control role-based permissions, groups, projects, budgets, and more. This provides the ability to allocate software and hardware resources in a controlled granular manner while maintaining the benefits of aggregated procurement and security controls at scale. Optionally, Rescale can implement single-sign-on (SSO) for an organization and provide direct integrations into internal schedulers (Platform LSF, SGE, PBS Pro, etc.) or support more advanced integrations via the application programming interface (API).
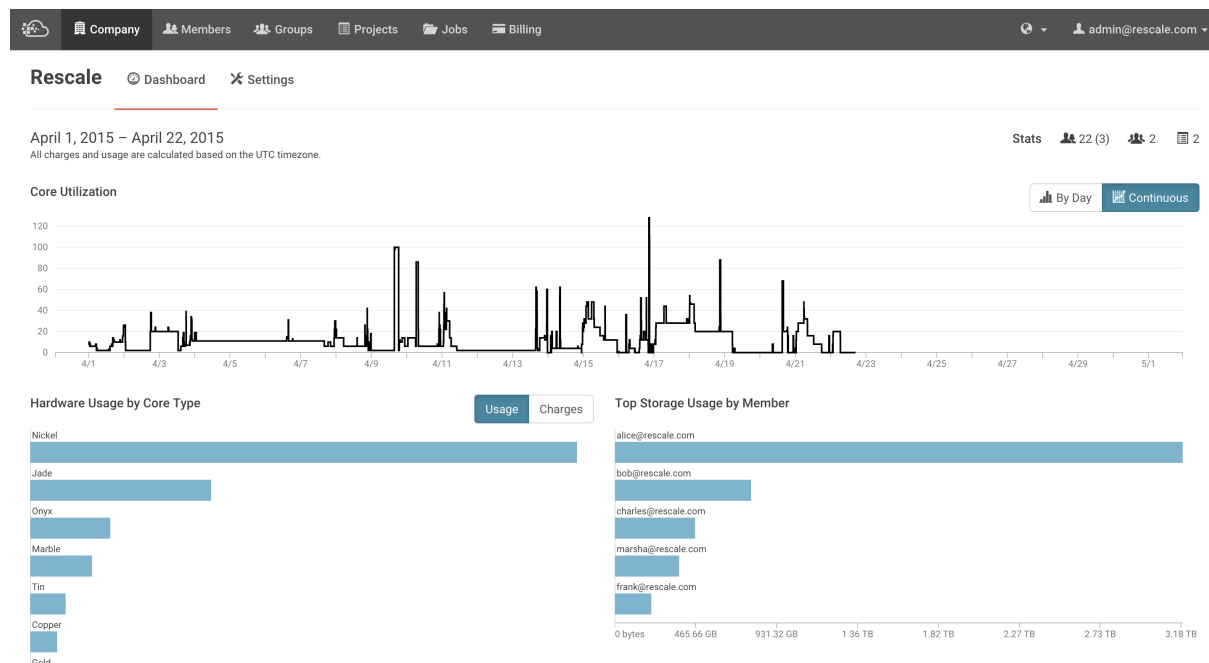
Fig.11: Rescale platform administrative portal

5 LS-DYNA Capabilities on Rescale

Rescale's cloud simulation platform is easily used to scale out LS-DYNA simulations. Users can instantly run multiple simulations in parallel utilizing an expansive number of cores. Rescale has over 30 globally-located data centers that offer 10,000+ cores to LS-DYNA users ranging from HPC, InfiniBand connection, GPU, and high RAM hardware. Users select the exact configuration, including,

RAM, disk storage, interconnect, and CPU type, that is optimized to their individual LS-DYNA simulation. There is no limit to the number of simulations a user can run in parallel. Through a strategic partnership, Rescale and DYNAmore work closely to offer suitable pricing models to LS-DYNA users. This allows for scalability of not only HPC hardware but also software licenses.

For general simulations, Rescale provides HPC hardware optimized for CAE simulations. One of these configurations is the Onyx core type. Onyx is one of the latest generations of HPC hardware with SSD storage, high interconnect, and the newest Intel processors. In recent benchmarking studies, Rescale ran a several million element vehicle crash simulation using LS-DYNA. Users can scale LS-DYNA simulations using well over 100 HPC cores. With the latest in HPC hardware technology available on Rescale's platform, the benchmarks ran 4x as fast as standard simulation hardware during benchmarking. This equaled over a 70% improvement in total cost savings for just a single simulation.

Results and performance vary depending on the hardware, model, and simulation requirements. Rescale works with LS-DYNA users to test the environment best suited for their specific needs. Additional benchmarking data will be demonstrated during the presentation at the DYNAmore conference in June.

6 Summary

Rescale provides an intuitive cloud simulation platform optimized to run complex LS-DYNA simulations. Enterprise companies can instantly access a range of customizable high performance computing hardware and leverage an elastic, dynamic platform designed to reduce capital and operating expenses while meeting the demands of various engineering and science teams. Users can execute multiple LS-DYNA simulations in parallel, monitor simulation progress in real time, and view results directly in the browser. Lengthy file transfer times are eliminated as users analyze completed LS-DYNA simulations directly in Rescale's platform using the built in remote desktop visualization feature, Desktops.

Enterprise companies can rest assured their proprietary data is secure with Rescale's complex system of security tools and procedures. Data encryption, kernel encryption, private clusters, and company administration control are just a couple of the ways Rescale secures user information. Leading Fortune 500 enterprises are paving the way by demonstrating clear cost benefits and agility for their organizations. For some, this is purely to handle peak LS-DYNA workloads and overflow. Other are realizing the economic, efficiency, and productivity increases that come with using a cloud platform for LS-DYNA simulations.

7 Literature

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