rescale

Intelligent Computing for Digital R&D

Rescale's Software-Defined Approach to Modernizing Science and Engineering Computing

White Paper

Executive Summary

IT teams have pushed storage and networking from legacy inflexible and inefficient models to a much more dynamic and agile management model. Core to this evolution has been the advent of software-defined data centers, which separate managing logical resources from the underlying physical infrastructure. This trend has dramatically reshaped storage and networking infrastructure, and now Software-Defined Computing (SDC) is emerging as a major force in scale-out, compute-intensive applications. Software-Defined Computing first changed the data center 15 years ago with the advent of server virtualization, and now is redefining how science and engineering's R&D applications and workflows are accelerated and optimized in the enterprise.

Rescale's intelligent software-defined computing approach transforms static hardware power into a dynamic resource that enables automation and simplified, rapid deployment for large-scale applications. With SDC, both line of business and IT managers can better match their needs to available compute resources without a need to understand the complexity of the underlying hardware. By combining SDC with workload intelligence, IT organizations can abstract and automate complex hardware decisions and configurations for their end users. This enables them to efficiently drive digital transformation initiatives and take advantage of the best and latest hybrid and multi-cloud technologies for each specific application.

In this white paper, we present the core ideas and new trends in Software-Defined Compute, and how Rescale automates SDC for IT and HPC organizations.

Key Take Aways

- Traditional infrastructure models lack flexibility, performance, and efficiency to meet the changing demands of modern R&D computing needs
- IT and R&D teams face increased complexity navigating hardware choice and varying cost-performance across hybrid- and multi-cloud options which can cause costly inefficiencies and delayed time-to-market
- Rescale's intelligent software-defined computing approach abstracts and automates complex infrastructure decisions and configurations leading to improved application performance, accelerated breakthroughs, and lower full-stack costs of compute operations

Current Challenges of Traditional Computing

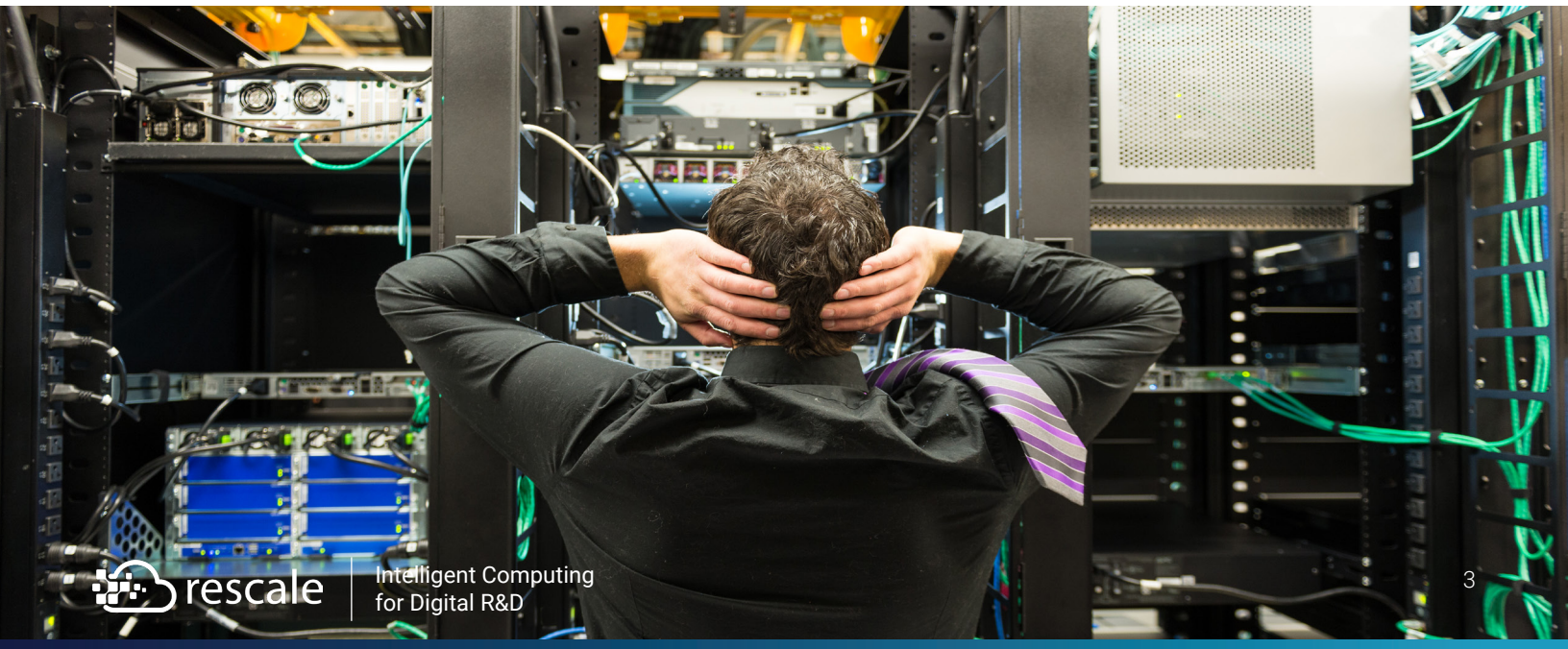
As we move to an increasingly digital world, the number of compute-intensive applications that require large scale resources is exploding. To stay competitive, businesses need to deploy compute at massive scale, including traditional high-performance computing (HPC) applications in aerospace, automotive, energy, and beyond. This exploding growth brings with it an acceleration of complexity, as every application has its own unique needs to take advantage of specialized accelerated hardware and the competitive options and scale available from multiple cloud providers.

However, much of today's compute infrastructure is static and deployed in silos, be it on-premises, cloud-based, or hybrid. Deployment at large scale is slow and difficult to respond to business needs. Large clusters of servers are procured in advance based on forecasts of how they might be used, but once deployed, cannot shift until they are depreciated after multiple years. Compute infrastructure has no built-in knowledge of dynamic application or geographic needs as they evolve, so architectural decisions must be made in advance for specific applications and physical locations. To deal with the risk of under-utilized capacity, IT managers require their end users to wait in a queue for shared, one-size-fits-all resources. This essentially locks end users into a single set of hardware choices for years at a time. This presents a challenge as the market continues to accelerate as new specialized hardware emerges and cost competition continues to drop.

In addition to procurement and performance limitations, traditional hardware strategies fail to realize the economic value of software-hardware optimization. For example, modern applications performing machine learning demonstrate improved cost performance across new ARM, RISC-V, GPU, and TPU architectures. Similarly, many CAE workloads like FEA and CFD see gains across various x86 architectures with specific clock speeds, interconnect, and memory configurations. To address this, organizations are increasingly migrating to multi-cloud strategies to take advantage of unique and improved hardware offerings for each of their software applications. While some are beginning to see this opportunity, few enterprises have the continuous benchmarking and integration capabilities to capitalize on it.

These challenges are even more acute as new cloud providers introduce even more complexity, including lack of standardized interfaces between providers, unique software requirements that aren't built for cloud, and the difficulty of finding talent that can succeed in both on-premises and cloud worlds. Often, what IT and HPC managers have learned is that on-premises does not translate to the cloud, especially given the platform differences between cloud service providers.

But cloud operating models push the envelope with just-in-time provisioning, on-demand consumption models, and distributed, dynamic resourcing. Today's modern IT administrators cannot ignore these, and need flexibility to be able to take advantage of the latest technology and operational innovations. There is a high opportunity cost to not seriously evaluate and prepare an organization for these changes.



The New Choice in Software-Defined Computing

Software-Defined Computing bridges the gap between on-premises and multi-cloud hardware. It moves control of how compute power is distributed away from static hardware to a more dynamic software layer, opening the door to automation and policy-based frameworks. This enables computing resources to be dynamically allocated based on application needs and business policies. The infrastructure does this by abstracting underlying hardware layers and exposing APIs, policy engines, and intelligence that allow IT administrators to easily and programmatically adapt to business needs.

Traditional alternatives do the job, but if IT administrators want to scale compute power quickly, it takes time and scarce, specialized resources. Because modern applications are unwilling to wait when other options are available, Software-Defined Compute disrupts traditional models by bringing the best of the cloud to on-premises in a multi-cloud, hybrid combination. Early movers are leading the shift to Software-Defined Computing, drawn by additional flexibility, scalability, reliability, performance, and lower cost. This approach allows IT administrators to utilize the best of what they have on-premises, while incorporating the future of new types of hardware and operating efficiencies.

The main idea behind SDC is to make it easier to provision computing power. With SDC you can forget about application performance tuning, hardware availability and capacity planning, and managing the complexity of many different application and hardware versions. With Software-Defined Computing, all of that is masked from users--what they get is an intelligent control layer that provides the capacity and performance tuning that each user needs for any specific application.

With Intelligent Software-Defined Computing, IT leaders can leverage a software layer to automate how large amounts of compute power are deployed, using service levels and custom policies, regardless of if the underlying hardware is on-premeses or in the data centers of cloud service providers.

Intelligent SDC from Data-Driven Models

In order to apply SDC to an increasingly complex landscape of hybrid, multi-cloud architectures, organizations need to build an operational model that can intuitively align business objectives to all available resources. Accomplishing this can lead to continuous value capture in performance improvements and reductions in cost.

IT leaders are discovering that software-defined compute operations can be optimized with knowledge of both a hardware's performance benchmark for a given software workload in addition to the capacity and resilience of a given hardware. This information can be combined with the cost of the hardware to get a holistic view of value and fit for specific hardware-software combinations. Rescale customers have seen these variables produce significant improvements in their full-stack economics, the efficiency of cost-performance for the entire compute stack.

Rescale's Data-Driven Indices for Intelligence

Rescale's data-driven approach has been developed over time to create comprehensive intelligence across all the latest cloud and on-premises benchmarks. Rescale intelligence is based on a combination of performance, maturity, and value indices. When factored together, IT teams can make confident decisions about how to best provision hardware based on their users' needs. Using this intelligence, companies can automate and abstract complex hardware decisions creating faster, simplified, and more efficient digital R&D practices. See figures 1 and 2 below for example composite hardware scores using RPI, RMI, and Value indices that help IT managers and HPC practitioners make cloud provider decisions based on their specific engineering workloads.

- **The Rescale Performance Index (RPI)** - a composite score of HW performance that incorporates workloads, common benchmarks, and various scales to facilitate performance comparisons by server configuration
- **The Rescale Maturity Index (RMI)** - a hardware rating based on an architecture's track record, capacity, and volume of core hours under operation
- **Value** - a combination of RPI divided by price of the infrastructure, which can vary across geographies

Figure 1 - CSP hardware comparison for Aerospace (aerodynamics) simulation run on Ansys Fluent where CSP #4 offers the best per-core value and per-core performance while offering competitive capacity.

Source: Rescale Cloud HPC Platform Analytics

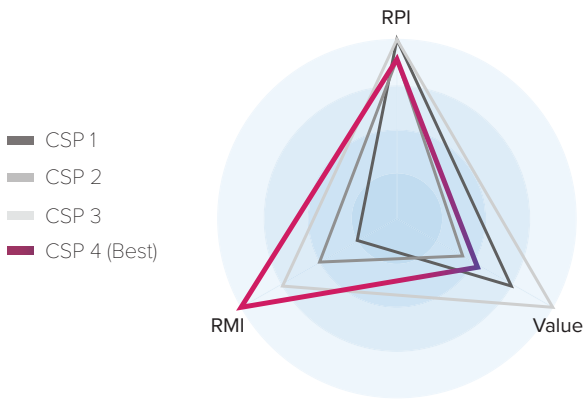
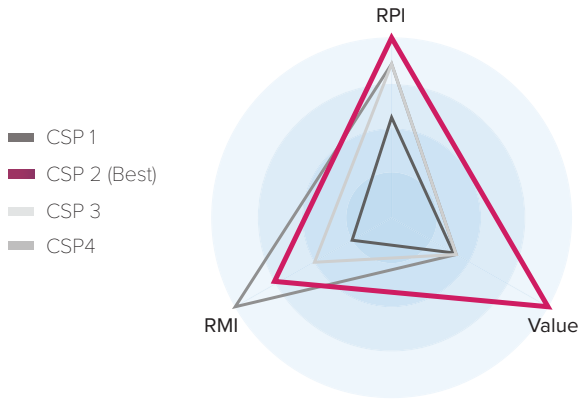


Figure 2 - CSP hardware comparison for an Automotive (crash test) simulation run on LS-Dyna where CSP #2 offers the best capacity with competitive value and performance.

Source: Rescale Cloud HPC Platform Analytics



Cost-performance gains can be seen when adopting the hardware released by infrastructure providers each year. For this reason, many organizations have embraced cloud transformation to not only take advantage of OpEx flexibility but also to capture the value from ongoing cost-performance improvements. Figure 3 charts the introduction of new cloud hardware available on Rescale from 4 major cloud service proivders (AWS, Azure, Google Cloud, and Oracle Cloud). As seen by the steady improvements in cost-performance, cloud provider hardware is now competitive with on-premises data center economics and and in some cases exceeding . As a result, the additional value capture of applying intelligent SDC can be 20% or more in YoY cost-performance improvement.

A key challenge to capturing this value is that not all cloud service providers offer the same hardware and instance options, which is why many organizations opt for a multi-cloud approach. Rescale offers customers on-demand access to a wide range of instance types with automated recommendations based on the workload and business objective. From automotive to medical device product simulation to design optimization, Rescale has benchmarked numerous workloads against the latest hardware available from each CSP. Figure 4 below shows the Rescale Performance Index of these four CSPs for their given hardware options. While the performance of each CSP portfolio varies, it's equally important to find the best architecture within the portfolio to get the best performance.

Figure 3 - Performance vs fully-loaded data center costs for a sample benchmark workload (higher is better)

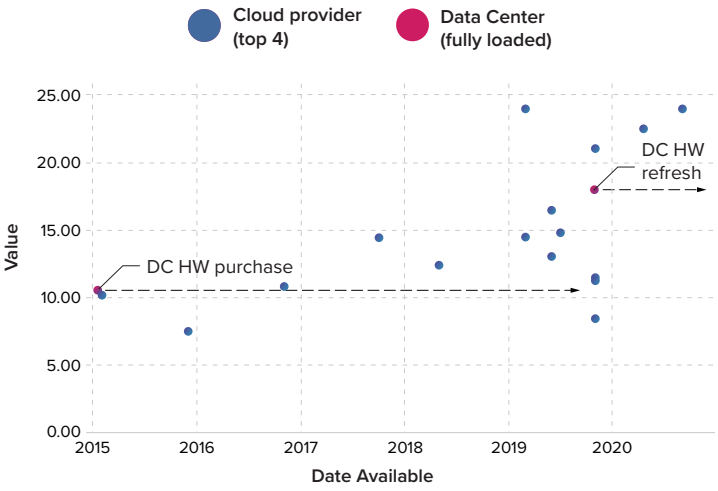
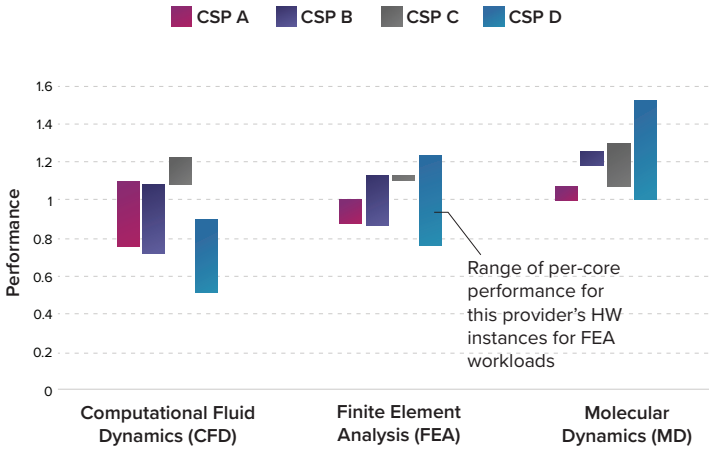


Figure 4 - Rescale Performance Index range by workload type



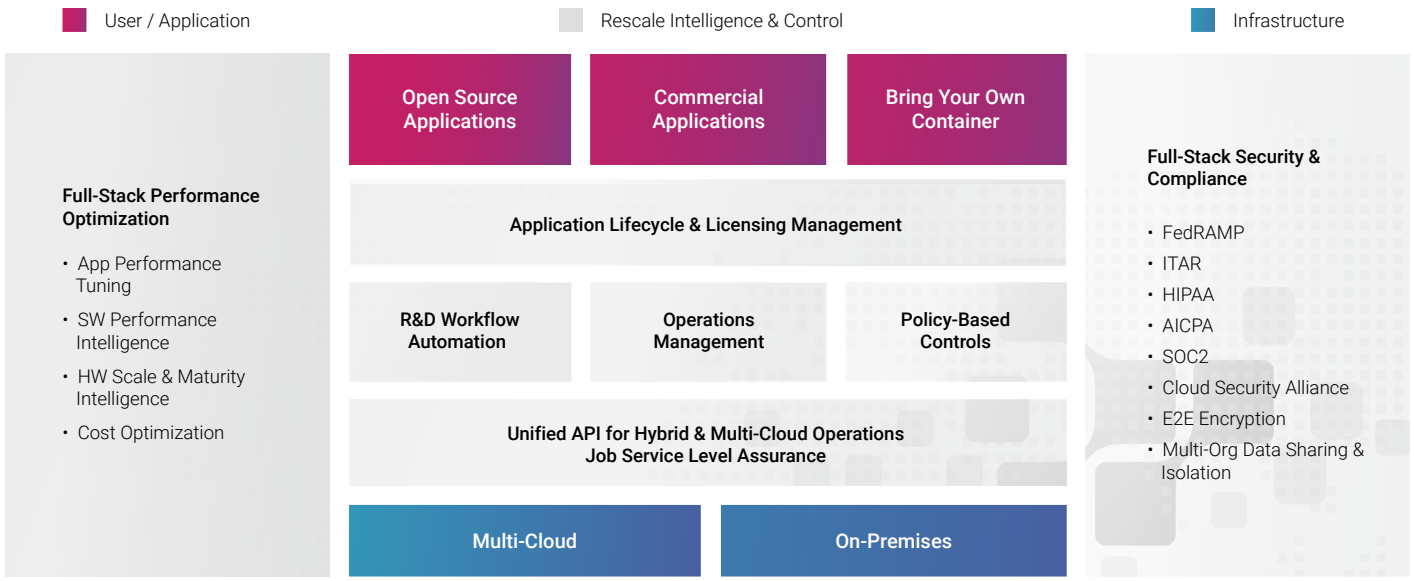
Deploying Intelligent SDC in the Enterprise

When business goals change, this intelligence can power full-stack optimization to balance resources based on the desired outcomes. For example, the automotive company in the figure below could choose to optimize their current HW configuration to 3 more optimal configurations for their crash test analysis. They could choose to optimize for speed to answer with a 40% reduction in runtime with only a 10% increase in cost using alternate HW 1. They could also optimize for lowest cost with an overall 20% reduction using alternate HW 5. Or alternatively they could lower costs while keeping time-to-completion (performance) the same using alternate HW 3. With big swings in performance and cost between hardware and software configurations, there is a high potential opportunity cost for HPC pracitioners who do not seriously consider full-stack economics.

Figure 5 - Full-stack economics analysis for a crash testing use case (FEA) across available hardware options

In addition to intelligence for optimizing the economics of hardware and software, Rescale gives IT and HPC managers complete control to ensure compliant and continuous HPC operations. Because Rescale is a comprehesive, end-to-end platform for both for admins and end-users, it serves as a control plane to connect the many elements of the HPC stack. With best-in-class compliance standards built in and controls for financial, architectural, access, and security managment, Rescale make it easy to gain valuable business insight to make decisions or protect against risks like data breaches or cloud cost overruns. Figure 6 below illustrates the Rescale platform architecture and how Rescale's unique intelligence and controls connect the HPC stack from end-to-end.

Figure 6 - Rescale, an intelligent control plane for unified HPC operations (Platform diagram)



Enterprises across industries can benefit from intelligent SDC, ensuring science and engineering teams have the most performant resources to minimizing IT troubleshooting and service downtime. Figure 6 illustrates how Rescale integrates its intelligent SDC to bridge the application and infrastructure layers, and brings automation and user-friendly abstraction to make complex descions simple, automatic, and continuous.

Capturing value from the new capabilities from intelligent SDC can be seen in several ways across the enterprise. These capabilities create a common ground for business, IT, and R&D users where their unique goals are met when previously goals like high utilization and high availability/capacity were often at odds. Enterprises with HPC intelligence and control observe the following challenges and then post-transformation benefits:

Traditional Computing Challenges	Intelligent Computing Benefits
Tight coupling between applications and infrastructure leads to a static, rigid deployment model	Increased flexibility by moving control to an intelligent software layer, decoupling applications and hardware
Managing on-premises hardware and cloud server provider is complex and requires planning and tuning	Ability to pool classes of compute power based on service level, reduces hard costs and management costs
Siloed operations for IT and HPC teams with low standardized governance	Centralized control by service-oriented Devops teams that scale with standards
Specialized skill sets required with highly customized processes and training	Simple provisioning and management with consumer-grade simplicity and automation
Difficulty managing TCO without integrating knowledge of project-level budgets and business outcomes	Full-stack optimization due to real-time adjustments to infrastructure choices and policies

Rescale Customer Spotlight - SSE Renewables

Large energy corporations like SSE Renewables can even leverage Rescale's full-stack optimization for their in-house bespoke applications to maximize their compute investments for wind farm analysis.

Rescale Customer Spotlight - Arrival

Technology disruptors like UK-based Arrival, specializing in electric automobile manufacturing, utilizes Rescale to manage a broad software portfolio and ensure engineers have access to the most performant hardware across each simulation requirement.

Rescale Customer Spotlight - Aerion Aerospace

"Rescale gives us compliance, control, and economic visibility with the best of the cloud, allowing us to work quickly, efficiently and in parallel with each other. Cloud computing is a fundamental part of Aerion's long-term strategy."

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Now let's take a look at the areas of business value capture and examples of enhanced capabilities brought on by full-stack automation and optimization:

Continuously optimized full-stack economics: Improved overall cost-performance and utilization of software and hardware resources. Alignment between IT managers and end users on the exact resources based on specific use case and business needs. Allowing users and their applications to get exactly what they need. This self-service model allows business users to choose the product and service level they want, decide how much is needed, and chargeback without the waste of pre-provisioning unneeded software licenses and hardware procured for peak usage, not real usage. By combining Rescale's intelligence and control across cloud and on-prem hardware types, organizations can define a set of preferred and contingency hardware options. This automates business continuity decisions in the event of capacity shortages or swings in spot market pricing.

Accelerated R&D initiatives and increased productivity: Given rapidly changing application environments, resources became more available on demand to make near instant business requirements. This enabled IT administrators to react in real-time as new workload requirements appear, so line-of-business users don't miss quickly emerging business opportunities. Also, they can quickly react to lifecycle needs as applications move from pilot to production or end of life.

Connected and empowered distributed teams: As R&D lifecycles get more complicated due to increasingly distributed and interconnected processes - think collaboration and co-design with up- and downstream stakeholders - organizations can dynamically provision the right hardware and software resources with policies that fit the user. Additionally, IT teams can make simulation data accessible for only specific users, teams, and projects keeping intellectual property and user data secure.

Complete control for business continuity, compliance, and traceability: Enforce best-in-class compliance standards, best-practices, project budgets and access policies for data, infrastructure, and hierarchy permissions for resilient business operations.

Reduced talent bottlenecks: Reduced need for expensive specialized skills, including application-specific maintenance and tuning across a wide number of applications, and hardware-specific maintenance and performance tuning across multiple cloud and on-premises hardware providers. Often, application and/or infrastructure challenges distract engineers from critical R&D work or strains IT teams as frequent workflow changes pose new challenges. Further, as companies build up highly customized solutions, any loss of talent can mean the loss of valuable institutional knowledge. Organizations on Rescale retain their knowledge of past optimal configurations and workload data lineage, allowing new engineers and admins to onboard quickly and accelerate productivity.

Conclusion

As organizations look to enhance their digital R&D capabilities, intelligent software-defined computing will transform the way technology leaders meet the needs of their end users - this time for HPC applications. Due to the rapid growth of new compute architectures and their variability of performance based on workload, IT teams need access to intelligence to identify and controls to standardize the best hardware and software combinations. Line of business leaders and CXOs are uncovering significant swings in overall performance and cost due to the interplay between hardware and software. By managing the full-stack economics, business leaders, infrastructure managers, and end users can find a compatible path to maximizing resources, optimizing costs, and accelerating time to market of new products.

About Rescale

Rescale helps organizations accelerate science and engineering breakthroughs by eliminating computing complexity. From supersonic jets to personalized medicine, industry leaders bring new product innovations to market with unprecedented agility, speed, and efficiency with the Rescale Platform - an intelligent full-stack automation HPC solution for digital R&D in the cloud.

IT leaders use Rescale to deliver high-performance computing-as-a-service to their organization by harnessing the power of automation on a hybrid cloud control plane with security, architecture, and financial controls.

Learn how you can modernize your high performance computing:

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