Lenovo and Rakuten
Edge-Optimized Cloud Solution for Communication Service Providers

Lenovo and Rakuten; Modernizing CSP Networks with Cloud Automation and AI-Enabled Edge Solutions

Rakuten Cloud Native Platform (CNP) solves the challenges in automating deployment, scaling, and lifecycle management of enterprise applications and 5G rollouts using the power of Kubernetes® and cloud-native services.

Rakuten Cloud Native Platform is optimized for delivery of services at the edge, providing an extensible cloud-native edge-cloud that can manage stateful workloads. This includes intelligent data management that automates and accelerates provisioning and lifecycle management. Rakuten Cloud Native Platform is designed to reduce Communication Service Provider's (CSP) operating cost, accelerate time to delivery and optimize hardware.

Rakuten Cloud Native Platform and Lenovo ThinkEdge SE455 V3

Rakuten Cloud Native Platform coupled with Lenovo ThinkEdge SE455 V3 provides CSP's a resilient high performing, energy efficient, secure AI-Edge service delivery platform for a variety of edge applications. Working together, CNP and Lenovo's ThinkEdge SE455 V3 deliver a critical solution that supports CSP's digital transformation.

Challenges facing Operators for Edge Service Delivery

CSP's face unique and complex changes specific to edge service delivery including:

- Lengthy time to market due to technology integrations size of projects and RFP contract process
- High cost of service delivery and operations but declining Average Revenue Per User (ARPU)
- Complexity around service monetization and management of new technologies
- Specialized infrastructure requirements tied to new use cases and

Edge Software Offers Multi-Tenant Service Delivery Model

Rakuten Cloud Native Platform Edge-optimized private cloud solution is designed to solve CSP's biggest challenges by delivering Edge software as a service delivery solution. This allows CSP's a multi-tenant service delivery model. This solution provides an integrated App Market Place to automate provisioning of edge applications coupled with centralized orchestration and zero-touch provisioning. Built-in intelligent application-aware data services and life cycle management accelerates time to service delivery and reduces CSP's network operations cost.

Lenovo Edge-Optimized Server Increases Energy Efficiencies

The ThinkEdge SE455 V3 powered by the AMD 8004 EPYC Processor brings 4th Generation Zen4c processor technology to the Edge. Zen4c enables more cores in a smaller footprint, delivering increased energy efficiency and high levels of performance. Up to 64 cores coupled with up to 6x Accelerators, 8x 2.5" SSDs, and 100Gb Ethernet networking allows user to benefit from more AI power, accelerated packed processing, and more workload consolidation.

Lenovo's ThinkEdge platform is optimized for edge in order to deliver faster insights at the Edge for AI, Telco, and critical workloads. With Edge-optimized compute performance from AMD, together with all-flash storage, acoustic optimizations, and robust security.

Built-In Security

At the Edge, your property and data are more vulnerable. Lenovo ThinkEdge SE455 V3 combats this with a lockable security bezel and top cover, and it can be secured into the rack with a security key to deter physical theft. Protection of the data includes using SED SSDs, TPM 2.0 with Secure Boot and the watchful XClarity Controller can even initiate a system lockdown should the anti-tamper sensors be triggered.

For additional details on models and configurations, visit SE455 V3 product page on https://lenovopress.lenovo.com/lp1724-lenovo-thinkedge-se455-v3-server

Components	Specification
Form factor	2U rack server, short depth (438mm depth, from EIA front rack flange)
Processor	1x AMD EPYC 8004 processor (formerly codenamed "Siena"). Supports up to 64 cores, core speeds of up to 2.65 GHz, and TDP ratings of up to 225W.
GPU and accelerators	Supports up to 6x single-wide GPUs and accelerators Supports up to 2x double-wide GPUs
Memory	6 DIMM slots. The processor has 6 memory channels, with 1 DIMM per channel (DPC). Lenovo TruDDR5 RDIMMs are supported, up to 4800 MHz
Memory maximum	Up to 576 GB with 6x 96GB RDIMMs
Drive bays	• 4x 2.5-inch hot-swap drive bays (front accessible), supporting SATA or NVMe SSD drives with hot-swap trays • Optional 4x 2.5-inch non-hot-swap drive bays internal to the server, supporting SATA or NVMe SSD drives. Drives are mounted in a cage that rotates up for easy access. • Up to 2x M.2 drives for boot functions, supporting SATA or NVMe drives (optional RAID with separate PCIe adapter)
Maximum data storage	61.44TB using 8x 7.68TB 2.5-inch SAS/SATA SSDs 92.16TB using 4x 15.36TB + 4x 7.68TB 2.5-inch NVMe SSDs
Storage controller	• Up to 8x Onboard SATA ports (non-RAID) • Up to 8x Onboard NVMe ports (non-RAID) • 12 Gb SAS/SATA RAID adapters • 12 Gb SAS/SATA HBA (non-RAID)
Network interfaces	Dedicated OCP 3.0 SFF slot with PCIe 5.0 x16 interface. OCP slot supports a variety of 2-port and 4-port adapters for network connectivity. Additional network adapters supported in the PCIe slots.

Components	Specification
PCI Expansion slots	Up to 6x PCIe slots (2x Gen5 x16, 4x Gen4 x8) in two risers, supporting full-height adapters. Riser 2 is optional. All slots are physically x16 slots.
Ports	Front: 2x USB 3.1 Type-A (5 Gb/s) ports, 1x USB 3.1 Type-C (USB-C) (5 Gb/s) with support for video connectivity (available dongle to convert USB-C to VGA), USB 2.0 port for XCC local management only, dedicated RJ-45 1GbE remote systems management port, External diagnostics port for local systems management, NMI pinhole.
Cooling	5x simple-swap 60 mm dual-rotor fans (all standard), N+1 rotor redundant.
Power supply	Up to two hot-swap redundant power supplies • 1100W Titanium or Platinum AC power supplies • 1800W Platinum AC power supply • 1100W -48V DC power supply Note: Power supplies are front-mounted so fan rotation is reversed compared to ThinkSystem servers.
Video	Embedded video graphics with 16 MB memory with 2D hardware accelerator, integrated into the XClarity Controller. Maximum resolution is 1920x1200 32bpp at 60Hz.
Hot-swap parts	Drives (in front drive bays only), power supplies
Systems management	Operator panel with status LEDs. Optional External Diagnostics Handset with LCD display. XClarity Controller 2 (XCC2) embedded management based on the ASPEED AST2600 baseboard management controller (BMC). Dedicated Ethernet port for XCC2 remote access for management. XClarity Administrator for centralized infrastructure management, XClarity Integrator plugins, and XClarity Energy Manager centralized server power management. Optional XCC Platinum to enable remote control functions and other features. ThinkShield Edge Mobile Management mobile app and XClarity Mobile app for local onsite edge server management.
Security features	Centralized security management with ThinkShield Key Vault Portal web site or manage security directly in XCC2. Platform Firmware Resiliency (PFR) Root of Trust (RoT), Trusted Platform Module, supporting TPM 2.0. Lockable top cover, intrusion detection, self-encrypting drive (SED) support, power-on password, administrator's password. Optional front locking security bezel with duplicate status LEDs
Operating systems supported	Microsoft Windows Server, Red Hat Enterprise Linux, SUSE Linux Enterprise Server, VMware ESXi. See the Operating system support section for specifics.
Mounting options	2-post rack, 4-post short-depth 600mm rack, 4-post 1000mm rack. Available locking security bezel with dust filter. Available security EIA brackets.
Limited warranty	Three-year customer-replaceable unit and onsite limited warranty with 9x5 next business day (NBD).
Service and support	Optional service upgrades are available through Lenovo Services: 4-hour or 2-hour response time, 6-hour fix time, 1-year or 2-year warranty extension, software support for Lenovo hardware and some third-party applications.

Rakuten Cloud Native Platform for Automation and Cloud Deployment

Cloud providers are faced with several challenges when modernizing and growing their networks and need to make continuous investments in order to introduce new technologies, like 5G. Rakuten Cloud Native Platform automates the whole Cloud deployment and life cycle management of complex data and network-intensive application pipelines as a service, including the demanding requirements of cloud native service delivery.

1.1 Cloud Platform Architecture

Rakuten Cloud Native Platform is an open Kubernetes platform that is optimized for running Storage and Network intensive applications on-premises or in any cloud. While native Kubernetes is the de facto standard for edge computing, it was not originally designed for service provider as a service delivery model. Therefore, with most legacy platforms, one must consider the following challenges met by CNP.

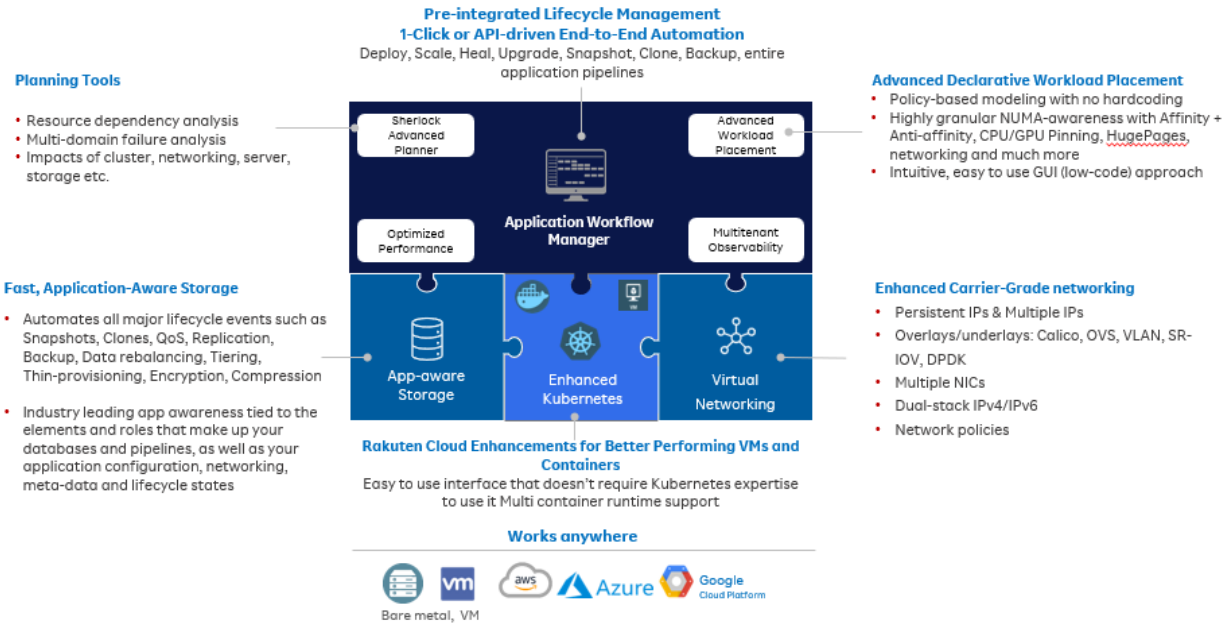
- Simultaneous support container-based Cloud Native applications and Virtual Machine (VM)-based Virtual applications on the same platform
- Automated Workload Placement
- Advanced Networking
- Advanced storage
- 1-click -as-a-Service deployments
- Support for enhanced data services, including Snapshots, clones and BCDR
- Enhanced affinity and anti-affinity rules and automation

CNP runs both cloud native and Virtualized applications in the same cluster, sharing resources in a common pool, while using the same onboarding procedures, you can run more applications than before. Furthermore, existing VMs run 30% faster on CNP than traditional VM platforms such as OpenStack – customer tested and proven.

CNP supports standard helm-based application profiles as well as enhanced application bundles that simplify the delivery and life cycle management of complex application pipelines as a service.

CNP starts with open standards, upstream Kubernetes without change and adds an enhanced CSI storage layer that includes unique application aware data services including snapshots, backup and clone and complex service level management capabilities. CNS is also available independently and supports any Kubernetes distribution.

The solution allows one to run both containers and VMs together, all the way down to the worker node level, providing optimal resource utilization, eliminating both resource and operations silos - 1 system with a unified way of doing things. We also added enhanced observability capabilities and Application aware automation capabilities.



CNP makes it easy to onboard new applications with an “as-a-service” model, in a secure, multi-tenant and roles-based environment. Furthermore, CNP provides these advantages using an intuitive, declarative interface, with advanced automation, reducing integration complexity, deployment timelines and human error, providing:

- A comprehensive set of life cycle management features simplify day 2 operations for deployed applications including Rolling upgrade automation, Scaling and performance management and application aware data services including:
- Application Aware Clone, clone entire applications (data + configuration +metadata) from production to test/dev.
- Scaling Automation, 1-Click or policy-based automatic resource scaling (vertical) and service scaling (horizontal).
- 1-Click application stop, restart, relocate (capabilities missing in vanilla Kubernetes or competition) ·
- Data protection, 1-Click application snapshot, time travel, backup & restore (for Helm-based and Bundle-based apps).
- Application mobility, 1-Click application portability across multiple clusters or clouds.
- 1-Click application upgrades that can validate on clone before upgrading production app

This provides an easy way to modify the resources assigned to the applications and present the use with a marketplace like experiences for on-demand deployment and life cycle operations like scaling and healing and performance management including complex provisioning policies and affinity and anti-affinity policies. All of this is fully automated, hunting for resources and hardcoding element parameters are completely eliminated. CNP and MDCAP does all the work for you.

CNP's user interaction paradigm centers on declarative programmable models. Declarative, as it asks for your desired outcome, but not all of the configuration steps to get there. This is possible because CNP presents all of the configuration parameters as programmable variables.

1.1 Security Solution

We do not classify our solution as a "security" solution. We do classify it as a cloud platform and automation solution that is "secure" that helps the operator and users operate in a safe environment.

- Our solution performs RBAC with a high granularity of different roles
- It is easily integrated with the customer's existing LDAP solution
- We can perform security scans in our automation "Service Designer"
- We integrate with the Istio service mesh
- Our team undergoes rigorous security scans of our own intellectual property as well as open-source components
- Rakuten Cloud Native Platform has ISO 27001 security certification

As part of Rakuten Symphony, additional security services can be offered.

1.2 Advanced Networking

NFs provide additional networking requirements that their enterprise counterparts don't have to deal with. Plain vanilla Kubernetes won't cut it from a performance or connectivity standpoint. Kubernetes pods need multiple connectivity options (Multus) and workloads need access to dedicated, high performance jitter free underlays that support network resource reservation. CNP supports Container Network Interfaces (CNIs) supporting multiple networking options that include Calico overlay networks, Open vSwitch (OVS), Overlay networking and Single Root Input/Output Virtualization (SR-IOV) Data Plane Development Kit (DPDK) high-performance underlays for optimal internal connectivity and external to legacy operations applications. CNP provides additional support for IP address persistence across, starts, stops, migrations and healing of network functions.

1.3 Support for Containerized and Virtualized Network Functions or applications

Not all applications will be available in cloud native form. Our cloud Platform supports running Virtualized and containerized Network functions or application simultaneously on the same cluster. This eliminates the need for siloed platforms. CNP deploys VMs directly in container pods with the standard

container PodSpec, without the need of a custom Virtual Machine Instance declaration adding additional that adds additional complexity.

The CNP CRI implementation allows for true Host Pass through that allows one to pin-CPUs directly to VMs for both unshared and shared implementations, bypassing elements of the hypervisor layer. This implementation improves throughput, isolation and lowers jitter.

1.4 Software Defined Storage

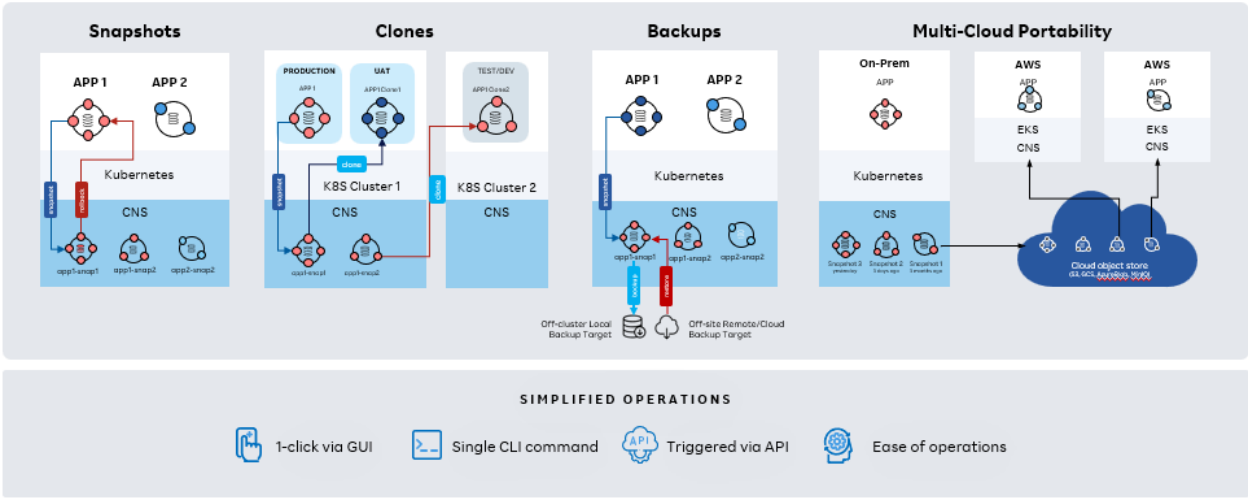
Rakuten Cloud Native Storage (CNS) software defined storage is included part of our CNP cloud offering and is incorporated via the Kubernetes CSI interface. CNS provides robust data persistency for stateful Applications including always-on availability with self-healing and advanced data placement. It is built from the ground up to support data and network intensive stateful and stateless applications.

CNS is the best of breed storage and data management solution for Kubernetes. CNS is built for high-performance that consistently beats competition with bare metal performance across many workloads. It is highly-scalable and supports multiple petabytes under management in production deployments at customer sites. It features:

- Built-in data resiliency through synchronous replication and automatic re-sync on failures.
- Snapshots, backups and clones are application-centric (captures application data, configuration and metadata). Built-in encryption and compression.
- Rapid failover of storage volumes to restore access to data even. under network partitions (8x faster).
- Built-in support for most databases and big data stores, including MongoDB, Cassandra, ScyllaDB, Postgres, MySQL, Oracle, Oracle RAC, SAP HANA, Elastic, Splunk, Cloudera, Hortonworks, and many more
- Supports IOPs-based guaranteed Qos
- Rich storage placement rules
- Supports disks, SSD, NVMe and your existing storage arrays
- Supports file, block and object storage
- CNS can support any type of storage device connected to the cluster and offers enhanced data management capabilities that is application aware.
- Automated data rebalancing to avoid data hit spots.

Snapshots can protect not only the persistent data volumes across multiple POD and nodes it also protects Kubernetes configuration including stateful sets, secretes etc. to any point in time. Snapshots are thin provisioned and based on redirect on-WR technology and does not consume additional replicated data.

CNS also provides backup and Clone capability which is very helpful or in place upgrade of stateful applications and network services.


Snapshots
Clones
Backups
Multi-Cloud Portability
APP 1
APP 2
Kubernetes
CNS
PRODUCTION
UAT
TEST/DEV
K8S Cluster 1
K8S Cluster 2
On-Prem
AWS
EKS
CNS
Cloud object store
Off-cluster Local Backup Target
Off-site Remote/Cloud Backup Target
SIMPLIFIED OPERATIONS
1-click via GUI
Single CLI command
Triggered via API
Ease of operations

2 Infrastructure Orchestration

Rakuten Cloud Native Orchestrator is a hyper-automation, multi-data center and multi-cloud, platform built on top of Kubernetes to automate all aspects of delivery and life cycle management of infrastructure and Network services end-to-end from metal to service.

Rakuten Cloud Native Orchestrator is based on cloud native technologies and achieve portability, efficiency and as a service delivery of network functions. The Open architecture allows MNOs to select the best of breed software defined elements from different providers while maintaining a unified and efficient infrastructure independent orchestration and automation processes.

Rakuten Cloud Native Orchestrator orchestrates and manages the lifecycle of any workflow including, bare-metal provisioning, cloud platform instantiation, Application provisioning and Methods of Procedures (MOPs), a metal to service orchestration, all of which can be auto-triggered through a policy engine. One platform, with unifying workflows.

2.1 Bare Metal-a-a-S & LCM

Before any application, NF or controller can be installed, a server must be updated and configured. Rakuten Cloud Native Orchestrator performs full bare-metal life cycle management and can verify, install, upgrade, configure and bootstrap your server infrastructure. These are not simple scripts, they are contextually-aware workflows with numerous user defined checks points and forks, that guide your installation to its desired conclusion. Transform a server, without configuration or operating system, via the Baseboard Management Controller (BMC), Ethernet or serial, connection. Monitor and manage readiness:

- Basic Input Output System (BIOS) and BMC configurations
- NIC, Solid State Drives (SSD), Field Programmable ASICs (FPGA), non-Volatile Memory express (NVMe), Redundant Array of Independent Disks (RAID), firmware upgrades
- OS installation, Drivers, Services and Software Packages

Rakuten Cloud Native Orchestrator bare metal provisioning has been used in numerous provider networks and spans a wide range of pre-integrated Intel and AMD server models.

2.2 Cluster LCM

Rakuten Cloud Native Orchestrator is multi-cluster aware and can simultaneously run multiple data centers. Multi-cluster designs are the norm in both 5G and private 5G, as discussed earlier, since application, NF and control resources can lie anywhere from the far edge to a national data center location. With Rakuten Cloud Native Orchestrator, you can deploy CNP locally, in the cloud, regionally, at the edge, at the far edge and in public clouds such as AWS EKS and Azure. You can use a standardized approach for some cluster designs as well as custom designed for particular locations or services. Like other declarative interfaces, elements in this case CNP clusters, can be modeled and reused. In this case, everything is captured in JavaScript Object Notation (JSON) scripts. Rakuten Cloud Native Orchestrator

editor allows you to open these scripts, modify them, check them for errors and enact them all on one motion.

Once instantiated, predefined automated workflows such as cluster upgrades, copy, master node changes, moves and deletes are pre-instantiated so you don't have to build them. Customers can also add additional workflows for custom behavior. Typical operations include:

- Installation and configuration of the Cloud platform
- Multiple HA models
- Configuration and cluster instantiations, scaling, healing and termination
- Upgrade of the K8 Clusters and configuration for observability

2.3 Application LCM

Rakuten Cloud Native Orchestrator contains several tools for defining applications, As was the case of cluster workflows, one can model the key variables, resources, networking, image location and other resource modeling parameters. Then Rakuten Cloud Native Orchestrator provides both prebuilt workflows that cover all of your lifecycle tasks, as well as customization options. Pre-defined workflows include instantiate, start, stop, upgrade, rolling upgrade, terminate and move for virialized and Containerized applications.

The only differences between implementing each are the package definitions. Any applications can be onboarded using Helm charts, 3rd party executors, Yet Another Markup Language (YAML) and custom scripts to create bundles that are available in a marketplace format.

Rakuten Cloud Native Orchestrator application management can manage variety of applications such as: data bases, big data solutions, AI/ML, analytics stacks, load balancers, message queues, controllers etc. The application life cycle manager works in concert with CNP to take advantage of advanced workload placement, networking and application aware storage.

2.4 Methods Of Procedures Management

A MOP is a generic term that describes any step-by-step sequence for performing any task. It tells technicians or automation tools how to execute the actions, in order to perform that task. In addition to this general functionality, the Rakuten Cloud Native Orchestrator MOPs facility can be used to manage the lifecycle of physical devices, such as radios, sensors and networking appliances. These are performed by taking "existing" or new scripts and ingesting them into the MOPs workflow. MOPs can be executed in batch jobs or triggered by a policy engine that records the change of component states or receives a notification. Rakuten Cloud Native Orchestrator can send values to a resident or remote Prometheus collectors that in turn feeds the policy engine. We also have a MOPs design studio to create and catalog your MOPs. All of these can be triggered automatically by our policy engine. MOPs can span multiple

domains, for example if a failure is detected, commands can be sent to servers, switches, SDN controller appliances, pagers, email, etc. in any order

2.5 Inventory Management

See the next section for more details. Rakuten Cloud Native Orchestrator has full observability into servers, compute nodes, networking and can directly correlate it to any Kubernetes cluster, and application. All nodes are auto -discovered and auto-tracked as you add, move, change and scale.

2.6 Edge Platform Operations

Rakuten Cloud Native Orchestrator and CNP have deep insight into all elements: physical resources, cloud platform, and services. Furthermore, it can correlate and display views across any strata from a full drilldown to a solution-wide view, including application, service, pod, node, cluster, server, datacenter, multi-cloud. Using these metrics, customize and monitor at multiple levels, not just top down or bottoms up. Based on this multi-level awareness, this information can be used to troubleshoot, auto-repair, migrate, notify or trigger a MOPs operation using a policy engine. The monitoring systems give you true everything-awareness as well as the tools to use it.

Assess the configuration, system health, readiness and usage of your bare-metal infrastructure and all the related resources IT resources.

Monitor your Kubernetes clusters. View pod level statistics, cluster health, performance and resource utilization, events, pod relocates, instantiations, terminations, persistent volumes created, volume relocations, disk rebuilds, volume rebuilds, users active, resource pool capacity, node capacity, kubelet daemons, node exporter (exposed via Prometheus), docker daemons, container, master status changes and many more.

Perform detailed drill down statistics for Services, infrastructure components and 3rd party applications on performance, utilization and health, replica set counts, auto-scale statistics and numerous usage metrics.

Rakuten Cloud Native Orchestrator is designed to enable chargeback and is capable of exporting all trackable metrics ranging from physical resource utilization, throughput, packet flows, per pod, per node, per cluster. These metrics work in conjunction with our multi-tenancy and roles-based access modules for fine granularity among users.

Another added feature of Rakuten Cloud Native Orchestrator's advanced correlation capabilities is to analyze those "what if?" scenarios with our "Sherlock" tool. Determine the blast radius impact of any system failure including, CPU core failure, unreachable network destinations, worker node restart, master-node failover, roll-out failure, cluster failure, multiple instance failure or for any other configuration variable using declarative modeling. Explore, plan and automate for any failure scenario. Blast radius analyses and automation are not limited to single events but can include multiple events across clusters and data centers.

*AMD and AMD EPYC are trademarks of Advanced Micro Devices, Inc.

*Microsoft, Windows Server and Azure are trademarks of the Microsoft group of companies.

*Red Hat Enterprise Linux is a trademark of Red Hat, Inc., registered in the United States and other countries.

*Linux is the registered trademark of Linus Torvalds in the United States and other countries.

*SUSE is a registered trademark of SUSE LLC in the United States and other countries.

*VMware ESXi is a trademark or registered trademark of VMware Corporation in the United States and other countries.

*MongoDB is a registered trademark of MongoDB, Inc.

*Cassandra is either registered trademark or trademark of the Apache Software Foundation in the United States and/or other countries.

*ScyllaDB is registered trademark of ScyllaDB, Inc.

*Postgres is a trademark or registered trademark of the PostgreSQL Community Association of Canada.

*Oracle, MySQL and JavaScript are registered trademarks of Oracle and/or its affiliates.

* SAP HANA is a trademark or registered trademark of SAP SE or its affiliated companies in Germany and other countries.

* Elastic is a trademark or registered trademark of Elastic N.V. and its subsidiaries.

* Splunk is a trademark or registered trademark of Splunk Inc. in the United States and other countries.

* Cloudera is a registered or unregistered trademark in the United States and other countries.

*AWS and Amazon EKS are trademark of Amazon.com, Inc. or its affiliates.

*All other trademarks are property of their respective owners and are only mentioned for informative purposes.

*Trademark indications such as ™ and ® may be omitted in the description of the trademarks of each company.

Click here for more information on Lenovo servers.