Executive Summary *The Zero Touch Data Center.*

RackN dramatically improves traditional data center operations by providing a suite of fully integrated modules that manage control from first boot with basic server inventory and firmware patching to Day 2+ requirements of complex applications. RackN packages this capability as operator managed on-premises software without any SaaS or external management requirement. By delivering the industry’s first Continuously Integrated Data Center platform, RackN eliminates manual operations, improves speed and consistency, and frees operators to focus on higher level value.

This document maps ten core feature areas: five where RackN fits with existing data center tooling, and five ways we add unique capabilities. Together, they create a platform that transforms today’s jumble of multi-vendor infrastructure into a seamlessly integrated whole.

The following illustration provides a visual overview for the features discussed in this introduction.

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In this review, we’ll be introducing advanced concepts like immutable, composable, intent-driven and declarative for next generation operations. While these concepts are important technical building blocks for our technology, they are mainly concepts for data center architects.

*The heart of RackN is working with real operators to solve real operational problems.*

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Overview

RackN Company

RackN software enables autonomous operation of edge and centralized data centers starting from the commodity physical infrastructure and then up to the application layers.

We are a software company specializing in data center automation based in Austin, Texas. We were founded by former Dell employees with a vision for managing the IT physical layer (aka bare metal) by making advanced techniques from cloud operators accessible at any scale.

We have delivered on that vision with our current software generation (shipping as Digital Rebar v3.14). We are profitable with production deployments and a global community of users. As a software company, we focus on building a generally available product with minimal customization. Our primary focus is on license sales with some consulting to support customer pilots and prototypes.

RackN data center automation takes an integrated platform approach: other companies offer tools that overlap but no other company has matched our combination of physical control, provisioning, workflow and multi-vendor support as an on-premises product.

Solid Foundations: Bare Metal Underlay

RackN knows that automation in the data center depends on building from a solid foundation. That is why we focus on fixing the physical layer first. Our composable approach to bare metal underlay makes everything else fit smoothly into place. We leverage deep discovery and introspection to verify systems are ready, patch them to ensure conformance and ensure machines are under control before proceeding.

Our deep bare metal integration ensures RackN automation is always robust and predictable.

Continuously Integrated Data Center

The Continuously Integrated Data Center is at the heart of our vision for the post-cloud data center. Our vision is not anti-cloud: in fact, we embrace the automation, APIs, control and deployment lessons learned in the cloud wave of IT. RackN instead rejects the idea that running infrastructure is too hard for anyone without massive scale. In the post-cloud world, commodity infrastructure can be managed autonomously without the toil, fragility or risk of current IT environments.

This approach allows us to revitalize both legacy on-premises infrastructure and bring innovation directly into our physical environments. What cloud operators call “the edge”, we manage like regular computing infrastructure. We believe in making all computing simple to manage so there is no “edge” for infrastructure.

We hope that you’ll join us on our journey into making infrastructure simple and practical again.

RackN Integrated Platform vs Point Tools

RackN provides complete lifecycle control for the data center’s physical layer without constraining the choice of hardware, network topology or operating system. There is no other platform that provides a high level of integrated control; however, there are point tools that provide some of the functionality such as configuration management, lifecycle controllers, IP allocation, Multi-cloud Infrastructure as Code (IaC) and metal provisioning. By design, RackN can either replace these tools or integrate with these legacy tools.

Working adjacent with existing systems, aka in “brown field” scenarios, is an important part of how we make our customers’ implementation successful. Let’s examine each legacy category to understand how RackN integrates or replaces these point solutions.
Configuration Management (e.g. Ansible, Chef, Puppet, Salt)

Configuration Management (CM) tools start from a provisioned systems that already has the operating system plus their agent or SSH keys installed. From that point, they use input data and specialized languages (DSL) to complete the configuration and install applications on the systems. By design, these systems are limited to working inside an installed operating system and rely on an underlying infrastructure control to manage the machines.

RackN can both replace or easily integrate with existing CM.

**RackN Features:**

- Customers often have an investment in CM systems that play an important part of the operational environment. We work hard to preserve that investment by integrating smoothly with these tools.

- RackN automation includes all the needed CM tooling to replace CM tools and would make it possible for customers to migrate away from one or more of their existing CM tools.

- Most CM tools require operators to pre-define how they want to configure their systems via a static inventory. RackN use of discovered and stateful data makes us on par with the best of breed tooling.

**RackN Differentiators:**

- RackN is able to orchestration CM across multiple reboots and operating system changes.

- RackN content packaging system significantly improves upon leading CM configuration systems by providing composable, versioned and integrated automation.

- RackN multi-site management features (see below) allow operators to automatically synchronize automation over a global fleet.

- RackN plugins allow orchestration to happen out-of-band from the system and even when the system is off.

- RackN events and log capture provides significantly more control.

Lifecycle controllers (e.g. Dell DRAC, HPE iLO, IPMI, Redfish)

Lifecycle controllers (LCC) provide out-of-band (OOB) management and system configuration for physical servers. There are two primary components of LCC: control and configuration. Control functions such as power on/off are relatively standardized; however, firmware is vendor specific. Since each vendor maintains their own OOB interface and configurations, LCC tools are single vendor. Even if a customer replaced all systems with the Redfish common API, it would not ensure that one vendor’s tooling will operate on other vendor’s equipment.

While OOB control is essential in production data centers, we do not believe it should be required in normal operation. In normal operation, systems remain under software control so relying on OOB management indicates a loss of control. We understand this may not be obtainable by all operators so RackN automation is able to provide multi-boot workflows both with and without OOB.

RackN can integrate with multiple vendors’ existing LCC to create a unified control and configuration LCC API.

**RackN Features:**

- While we support OOB configuration via LCC, we do not recommend this approach because it is fragile and hard to manage. RackN uses “in-band” configuration using vendor tools during our discovery / recovery phase.

- OOB LLC tooling can be very difficult to audit, troubleshoot and coordinate for operators. Customers’ should be aware of production risk when using these tools.
RackN Differentiators:

- RackN supports a wide range of vendor LCC and versions of LCC so that customers can maintain a heterogeneous fleet.
- RackN integrates both soft and kernel (kexec) reboots into normal automation. These options can speed or eliminate server posting during reboots.
- RackN is able to integrate OOB operations into standard workflows and automation so that operators can mix physical (LCC) and logical (CM) actions in the same process. This allows for much faster and deeply integrated delivery.
- RackN is able to work with advanced security features of the LCC and hardware to ensure correct configuration.
- RackN is able to treat OOB management as an API driven operation. This creates several important benefits:
  - Physical automation can be tested accurately against virtual infrastructure
  - RackN RBAC and tenant security can be applied to OOB control for self-service users.
  - RackN logging and events can be monitored to provide additional verification

IP allocation managers (e.g. DHCP, DNS, IPAM, Netbox)

IP allocation managers (IPAM) play an essential role in data center operations by governing how devices connect to and are discovered on the network(s). Unlike other categories, the IPAM tooling is still relatively fragmented with customers relying on a variety of different services such as dynamic IP allocation (DHCP), static allocation (true IPAM), naming (DNS) and management.

RackN can replace or collaborate with DHCP. All other IPAM services are managed by existing integrations.

RackN Features:

- RackN allows servers to have multiple network interfaces and that requires a single system to have a number of different mechanisms for IPAM from static for OOB, DHCP for management/PXE and a mix for other interfaces.

Multi-cloud Infrastructure as Code (e.g. Terraform)

Multi-cloud Infrastructure as Code (IaC) is a tooling category that allows developers to automate infrastructure building and teardown operations against cloud APIs. This allows teams to define multi-system environments in a declarative way to be built automatically using an cloud API (aka an Infrastructure as a Service or IaaS). These tools are designed as a middle layer between an IaaS and CM systems so they require customers to maintain both systems.

While RackN provides bare metal IaaS APIs to enable IaC integrations, it also offers a complete IaC feature capability that integrates with our other control features.

RackN Features:

- IaC is an important design discipline for scale operators and is highly encouraged by RackN.
- RackN content and workflows provide all the features of an IaC platform with significantly more control and state management.
- RackN bare metal APIs are designed for easy self-service by IaC tools while also being highly transparent for operators to monitor and support self-service users.
RackN Differentiators:

- Since RackN API keeps running service, it is able to maintain the state of the system in addition to providing declarative configuration.

- RackN events and plugins allow operators to integrate IaC actions into other workflows and notifications.

- RackN content management system is both versioned and code controlled to be an ideal IaC format.

- The unique RackN composable architecture allows teams to collaborate on IaC components with clear separation of duties.

Bare Metal Provisioning (e.g. Foreman, Cobbler, MaaS, PXE)

Bare Metal Provisioning (BMP) installs operating systems (O/S) on physical servers using a variety of processes. The most common, netboot via kickstart or preseed, requires detailed knowledge of the target system and a carefully controlled sequence of bootstrapping operations via DHCP, PXE and HTTP components. The preferred alternative, image deployment directly to disk, requires complex pre and post provisioning operations to map a captured O/S image onto a physical disk layout. In all cases, simply installing the O/S is not sufficient and BMP systems also provide a mechanism to install an agent and/or user credentials to allow CM to complete the configuration.

We believe that BMP and LCC must be managed together: LCC changes to system configuration (RAID, BIOS, firmware, networking) will change profiles delivered for BMP.

RackN provides best in class BMP supporting a wide range of processes and systems. RackN is also able to integrate with existing BMPs by having them hand off to the RackN agent to complete installation.

RackN Features:

- Legacy BMP can be complex and fragile for production operations. Customers can reduce risk by finding a partner to manage and maintain BMP profiles.

- O/S and machine configurations are constantly evolving. Customers should anticipate that configurations will not remain static.

- BMP is only a small stage as part of system commissioning so integration and handoffs are critical.

- BMP should not be treated as a one time activity. Best practice data centers assume a constant refresh cycle for operating systems.

RackN Differentiators:

- RackN offers highly available and high scale configurations for BMP. Unlike vendor server management wrappers, our designs assume customers are driving BMP from other automated processes that rely on consistent results with accurate feedback.

- RackN small footprint can be run and managed from a top of rack switch to minimize data center overhead.

- RackN provides many performance enhancements for BMP that improve provisioning speed 10x or better.

- RackN offers image based deployments for a wide range of O/S.

- RackN has advanced integrations for VMware ESXi that provides unmatched control of the process.

- RackN discovery and templating process simplifies BMP processes by allowing configurations to be automatically customized for each system.

- RackN DHCP integrations enable improved performance and control compared to other BMP systems that rely on an external DHCP system.

- RackN supports advanced security configuration that reduce or eliminate insecure protocols during BMP.

- RackN workflows and classifiers allow systems to be provisioned without any human input when needed.
Virtualization / Container Platforms (e.g. VMware, Kubernetes)

Virtualization and Container Platforms (aka Cloud) support workloads at a higher abstraction layer. While Virtualization may be presented as “infrastructure” to end users, it is still a platform that must be installed and maintained on the physical layer infrastructure. For this analysis, while virtual and container platforms are abstractions intended to hide the physical layer they must still be correctly installed and maintained. Maintaining these platforms requires the ability to build to very exact specifications and then interact with the platform to coordinate upgrades.

RackN was designed with this purpose in mind: our ability to provide a completely integrated underlay supports ongoing operation of these complex platforms.

RackN Features:

- Platform deployments are greatly simplified with proper control of the underlay. RackN has proven the ability to automatically install platforms in minutes based on the degree of control that we bring to the physical layer.

- Platforms provide a degree of abstraction for users; however, many implementations require very specific configuration and awareness of the physical layer under the abstraction. The RackN platform allows operators to avoid this limitation.

- Upgrades and maintenance, aka Day 2 operations, are essential for production operators since the new platforms, like Kubernetes, have aggressive release and patch cycles. It is imperative for customers to be able to replace and patch their fleet on a monthly basis.

RackN Differentiators:

- RackN provides robust control of bare metal and allows Kubernetes workloads to be deployed directly without the need for a virtualization layer.

- RackN workflows are able to collect information about the platforms during installation and management. These allow RackN to perform zero touch installations and self-guided upgrades.

- Unique RackN VMware integration is able to perform very exact deployments of ESX and then include post-configuration as part of our workflow.

- RackN is able to verify hardware compatibility including firmware levels prior to installing VMware. This ensures a successful deployment.

- RackN has multiple Kubernetes installation options, discussed below, that are designed to work with our customers' operational choices.

- RackN is able to deliver both installed and live (in-memory) operating systems based on customer requirements during configuration.

RackN Platform Differentiators

Our vision for the data center forced us to start with real objectives for operations because we know real change does not come from simply replacing data center tooling with better versions of the same tools. At the same time, we felt that our software must not require proprietary or single vendor solutions. This approach led us to build a platform that worked with existing environments and systems in innovative ways.

Our definition of “disruptive innovation” works with existing infrastructure and historical protocols because we know that today’s great idea is also tomorrow’s legacy platform. Building for the future still means being able to create bridges between technology generations. That design flexibility is our most important differentiator.
Heterogeneous / Multi-Vendor

RackN knows that data centers are heterogeneous environments. Our customers use multiple vendors, highly variant configurations and have specialized needs. Even customers who stay with a single vendor will struggle with model differences that create significant operational variation. RackN incorporated this knowledge deeply into our architecture by making our system easily extensible and field patchable.

Customers benefit in several ways from RackN supporting a wide range of vendors. In addition to supply chain diversity, customers get to standardize their control approach. This allows operators to upgrade and migrate to new generations of systems. For example, RackN tolerates systems that use both legacy or new UEFI BIOS and both IPMI or Redfish LCC. This unmatched flexibility dramatically simplifies buying and migration decisions.

The RackN platform offers unmatched forwards and backwards compatibility.

Key Features:
- Single unified control and configuration API for a wide range of infrastructure
- Works both in-band and out-of-band to leverage the best APIs available
- Can support multiple protocols in parallel including IPMI, Redfish and vendors APIs
- Dell, HPE (including Moonshot), Supermicro, RPi, and Lenovo support
- Multi-Architecture: AMD/Intel and ARM64
- Multi-Protocol: PXE, IPXE, Mac Boot, Traditional & UEFI BIOS
- New vendor support typically takes just days to deliver

Composable / Immutable Automation

RackN places a lot of importance on our customers' ability to reuse operational automation. To accomplish this, we had to solve several difficult challenges.

First, we had to allow small improvements all over the platform that could be redistributed to running systems safely. This led to a composable design in which the system is built from many modular components. Our unique content and plugin system allows each of these components to be safely replaced via remote APIs even in a running system.

Second, we had to provide a way for automation to "work backwards" to build a functional machine from nothing into the desired output. This approach, known as intent-based automation, is the basis for our Workflows. Workflows allow operators to select a target state and allow the RackN platform automatically deliver the right process. By taking humans out of the process, we have an immutable, fully described process that is still fully observable and transparent.

Third, we consistently track the state of the system during operation. The RackN platform provides a persistent API that runs in customers’ data centers. That allows the service to collect and share information about systems during discovery and configuration. As a service, the RackN platform is always up to date and can act as a central data center information hub.

RackN platform provides unmatched status and control from first boot to on-going data center operation.

Key Features:
- Completely field upgradeable via REST APIs
- Individual components are delivered read-only and versioned to ensure they can be safely replaced in running systems
- System configuration information can be completely described by source controlled artifacts leading to a complete infrastructure as code (IaC) capability
- Individual sites do not rely on central configuration and can be "air gapped" or isolated for autonomous operation
- Customers can safely mix their own proprietary, RackN licensed and open content into operational systems
- RackN has an extensive (and growing) library of components for common tasks
Zero Touch Workflows

Currently, physical layer automation requires coordinating operations over multiple control APIs. Even the most basic provisioning operation requires interacting with at least four different protocols and typical enterprise deployments need up to ten. Any operational gap means relying on manual steps, brittle default or fragile pre-configuration.

We built RackN automation to span control interfaces in a single workflow so that data center orchestration is seamless and fast. In addition, our focus on extensible integration ensures that we can quickly handle new and custom systems.

Zero Touch is even more important on Day 2 than during the initial configuration. Our Continuously Integrated Data Center (CIDC) vision requires that we consider how a system is managed after it’s initial deployment because adding new systems is easy compared to updating and reconciling system history. This ongoing management is critical because production data centers must constantly update and refresh system to keep up with security, patches and workload demands. The RackN platform is designed with updates and reprovisioning in mind.

Delivering 100% automated processing on the first and every following cycle is central to the RackN vision.

Key Features:

- Completely automatic processes from discovery to final configuration
- Define rules based on system profiles to drive automation
- Self-service “metal cloud” API allows users to request and return systems
- Fully logged and evented actions create comprehensive audit trail for all operations
- Specialized recommissioning operations ensure smooth Day 2 operation
- Integrated burn-in, inventory, discovery, reconciliation and secure decommission stages are part of the RackN offering

Multi-Tenant, SSO & RBAC

Security must not be an afterthought in the data center: RackN designs for enterprise operation from the most basic API up to complete self-service cloud interactions. Our systems can handle the most demanding security needs from allowing multiple teams to consume our API (multi-tenant) to delegating user authentication to external sources like Active Directory. In additional to these integrations, all actions in the RackN platform are logged and evented so that complete audit trails can be created.

Since security is managed at the RackN API, customers can use the platform to isolate critical infrastructure from direct users. This abstraction provides an important and previously missing control layer for customers’ data center operations teams.

RackN works hard to deliver secure by default systems from simple PXE boot hand-offs to complex user facing security.

Key Features:

- Customers can lock down self-service or delegated actions to very narrow constraints
- As an additional layer, encrypted parameters ensure that sensitive data is restricted natively in the system
- Role based UX Views ensure that different user classes only see relevant material for their experience
Multi-Site & Edge Federated Control

RackN has implemented a distributed management system that allows for multiple enterprise or edge data centers to be operated in a consistent way. Our approach is unique for several reasons.

First, each site retains autonomous control over its resources. While the federated single-pane-of-glass management layers get updates and can delegate requests, each site retains direct control over its local resources. This design ensures that lack of remote network connectivity does not stop operations.

Second, each site uses transaction logs and event subscriptions to maintain synchronization. Actions from any site can be synchronized at global scale with minimal overhead. By subscribing to events between systems, operators get the items of interest at their area of operational scope.

Third, RackN managers leverage our unique IaC content and plugins to ensure that distributed systems are in a known and repeatable configuration state. RackN tooling helps to coordinate and synchronize these components based on specialized content catalogs.

This patent-pending technology dramatically streamlines management of RackN for large and remote deployments. Only the unique combination of autonomy, APIs and IaC could accomplish this balance of federated management.

Key Features:
- Each site remains autonomous without requiring constant connectivity
- Leverages RackN IaC approach to create a consistent operational model
- Allows for multiple tiers of centralized control
- Eliminates risk of multi-master distributed data by using integrated command proxies.
- Helps manage high availability (HA) cluster configurations
- Simplifies moving automation from dev, test and staging environments into production

Significant Additional Features

In addition to the ten core feature areas outlined so far, RackN has delivered specialized integrations to support advanced customer demands.

Dynamic Contexts

Contexts extend the integration capabilities of the Digital Rebar Platform (DRP) to effectively manage any type of device ranging from a switch, storage, sensor to a complete platform as part of our normal infrastructure as code (IaC) workflows. One important benefit of Contexts is that they leverage devices’ own APIs or CLIs running safely in containers to be used without specialized programming.

DRP Contexts allow a standard configuration workflow to run in different environments depending on the needs of any specific stage in the workflow.

This means that operations can transfer control from an agent on a machine back to the DRP server for actions on another API where the agent cannot run such as a switch, storage appliance or embedded device. For systems that cannot run an agent at all like an IoT device, DRP can create a proxy Contexts and that manages that embedded system’s full life-cycle.

Because Contexts allows DRP to run it’s agents without having a dedicated device to run the agent, there are several critical benefits for proxies, mixed mode, remote, and detached operations. In all these cases, DRP is able to change Contexts during a workflow. This allows operators to build workflows that share data and combine any of the above operations with normal server based agents functions.

Continuously Integrated Data Center

RackN uses the term Continuously Integrated Data Centers (CIDC) to describe our vision of a fully automated data center environment. That vision is the path to true control from both the initial bootstrap to a fully functional, always available data center that can be safely upgraded, including the infrastructure, using infrastructure as code techniques.
CIDC means operating your data centers in a way that allows for validation of infrastructure changes from lab to test to production in an automated fashion. This will assume fairly tight restrictions around access and control.

CIDC can use a set of environments for testing and validation with the goal to describe the validation deployment path for a medium to large organizations (1,000 to 100,000 machines) with the ability to reduce the number of pieces in place if you need to scale down. Validation needs to include both the operating systems of machines and the infrastructure.

**VMware Cloud Formation**

RackN combined our ESX provisioning capability with our discovery and control features to integrate deeply with VMware Cloud Formation. This feature allows RackN collaborate with VMware to perform a complete verified zero touch cluster bring up on a wide range of commodity infrastructure.

**Kubernetes Integrated Bare Metal Bootstrap**

RackN has created a completely automated, highly available Kubernetes installation process (aka KRII) based on the community installer known as “Kubeadm.” This process leverages RackN workflows and shared data in profiles to build a cluster without any manual intervention. The system supports both installed and live boot operating systems.

The unguided process is able to select cluster leaders, build and share security credentials, install prerequisites and perform post-deployment operations on bare metal systems. In addition to initial deployment, we have defined processes to allow rolling upgrades of nodes.

RackN also has a dynamic Ansible Inventory integration. This approach works well for operators who prefer community “Kubespray” for installation.

**Batch Machine Creation**

(e.g. EDI Rack Ingest)

Rack ingest allows customers to pre-populate system data before delivery. RackN normal processes rely on discovery to populate system information. In the Rack ingest process, data is preloaded and then verified during discovery. This process allows customers to certify delivery against shipping manifests. It also allows customers to maintain data like rack position that cannot be easily discovered during normal operations.

**Conclusion**

We’ve shown many ways that RackN redefines data center automation; however, we also work hard to getting started easy. Customers often choose to start their RackN journey from one or two of our best in class capabilities like provisioning or lifecycle control. The next gen infrastructure journey starts with small steps, bring in all the lessons learned from the cloud, and then leads to something much much bigger.