Joyent SmartDataCenter

A Joyent White Paper

A Superior Solution for Building, Running, and Managing Service Provider and Data Center Clouds

Build a cloud environment. Manage a virtual data center. It's that easy, right? No, not exactly.

Building a highly scalable, high availability, geographically distributed cloud requires thoughtful architectural design, resilient infrastructure, and flexible compute resource provisioning. Managing the cloud requires a deep understanding of industry best practices. Maintaining Quality of Service (QoS) and honoring Service Level Agreements (SLAs) require real-time monitoring and granular analysis. The complete cloud solution has remained elusive....until now.

Joyent SmartDataCenter addresses the key concerns and needs of service providers that wish to build their own cloud environment. For the past six years, we have built and operated the highly acclaimed Joyent Cloud and, in parallel, developed and refined the world's most advanced, carrier grade cloud infrastructure platform: SmartDataCenter. Built to our own exacting standards, we have used SmartDataCenter to deploy, grow, and operate our own large scale—and profitable—public cloud business.

Successful cloud businesses are one part groundbreaking technology and another part compelling operational, business, and go-to-market propositions. Technically speaking, the field-proven SmartDataCenter is the unrivaled performance, reliability, and flexibility leader for service provider clouds. And businesswise, Joyent provides an invaluable jumpstart for service providers by providing expert business modeling, design, operations, and go-to-markets. Deployed in tandem, Joyent

SmartDataCenter and Joyent's best practices accelerate service provider deployments and new business development.

Meeting Operator Cloud Business Objectives

Like other operator services, clouds must provide benefits for both providers and their customers. For service providers, clouds should drive new business opportunities, offer higher value than the competition, create customer pull and retention, and provide a solid financial return. For provider customers, the service should offer compelling economic value relative to other alternatives, evolve to meet changing requirements, and provide predictable and reliable service.

To meet their business and financial targets, providers need their clouds to be efficient and deliver a high level of performance relative to the resources required by competitive alternatives. Provider clouds must also be flexible enough to meet changing market conditions for growth, support new services and roll out new offerings in a timely fashion, and readily interoperate with other services and capabilities as required. Finally, providers should have the ability to deliver high-speed services that consistently meet customer expectations for service continuity (often defined in the form of service level agreements).

SmartDataCenter delivers against service provider business imperatives in multiple manners. First and foremost, SmartDataCenter is ultra high performing. Joyent SmartMachines allow for unique resource pooling and application optimization that results in far better CPU utilization due to higher multi-tenancy per physical server, faster CPU processes and a smaller, more sustainable footprint. Independent benchmarks have demonstrated that the operating system in SmartDataCenter, SmartOS, uses far fewer servers and lowers compute costs by delivering up to 14x faster speeds. And higher performance with a markedly smaller footprint means higher operating margins for service providers.

The big enemy of performance is "latency". Latency is the time delay that occurs between the initiation and the delivery of a service. Latency is becoming increasingly unacceptable as customers employ more real time applications and services that include voice, video, streaming content, and interactions that demand immediate response. The operating system-based virtualization in SmartDataCenter enables higher performance than in hardware-based virtualization and helps to fight minimize latency in the cloud.

Cloud analytics provide threshold and performance monitoring from the processes running in a single SmartMachine all the way up to broader overviews of a geographically dispersed cloud data center. High performance and complete transparency means that providers can virtually eliminate resource chokepoints, so that providers can deliver much more reliable service level agreements based on clouds that can be continually monitored, measured, and improved upon.

SmartDataCenter also accelerates cloud deployments and the delivery of new services. Joyent has designed its runtime and orchestration capabilities to automate server configuration. And with underlying APIs that speed operational software and billing integration as well as build out and customize visual control room views, Joyent SmartDataCenter's Cloud Operator Portal brings all the management and provisioning into a single console with extensions into Joyent SmartDataCenter's Cloud Billing and Cloud Customer Portal.

In addition, Joyent facilitates time to market by providing business enablement packages built upon six years of running a profitable public cloud. By leveraging our experience and expertise, service providers have a proven formula for success. Taken together, SmartDataCenter and Joyent's best practices can significantly reduce time to market for service providers wishing to roll out cloud environments and achieve the industry's best profitability per square foot of cloud resources.

The following pages review the key elements of SmartDataCenter.

Joyent SmartOS

The Complete Modern Operating System

Joyent SmartOS is the core of Joyent SmartDataCenter and provides a comprehensive, secure server operating system environment. It leverages best-of-breed technologies that deliver the strongest virtualization options, and new market, revenue and profit potential to cloud service providers.

Providing true multi-tenancy for legacy and next generation applications, Joyent SmartOS is the *only* cloud server solution that can *manage both KVM hardware virtualization and operating system-level virtualization on a single OS.* In providing support to both virtualization approaches, Joyent SmartOS eliminates the need for multiple technologies to support heterogeneous infrastructures and enables a single interface to all applications. With Joyent SmartOS, you can manage legacy applications running on traditional systems alongside cutting-edge next generation applications, a PaaS or SaaS, ultimately maintaining the experience for the end user while increasing efficiency and reducing complexity for the operator.

Using ZFS technology, Joyent SmartOS provides a combined file system and logical volume manager that is enterprise class and carrier grade. Joyent SmartOS delivers a powerful, local storage subsystem including copy-on-write support (snapshots). The utilization of local storage on ZFS distributes risk to ensure business continuity.

A core element of Joyent SmartOS is DTrace technology. DTrace provides visibility and insight. It works at any level in the application stack to safeguard SLAs and create a collaborative environment to troubleshoot challenges in real time between the end user and the service provider.

The security features built into Joyent Smart OS focus on key security and governmental standards including EAL 4+ compliance. Joyent SmartOS is security-hardened and designed to isolate network processes, storage and memory on a virtual server.

Collectively, these features provide customers peace of mind and ensures that data is safe. Joyent SmartOS eliminates the need for expensive storage that historically has been a problematic single point of failure. Last, with true multi-tenancy support, customers are shielded from "bad neighbors".

Although Joyent SmartOS is a fully maintained operating system, Joyent has open sourced it. There are no license fees. There is no need to track the number of seats or processors. It also ensures that you are not tied to a specific OS vendor for the control of your environment.
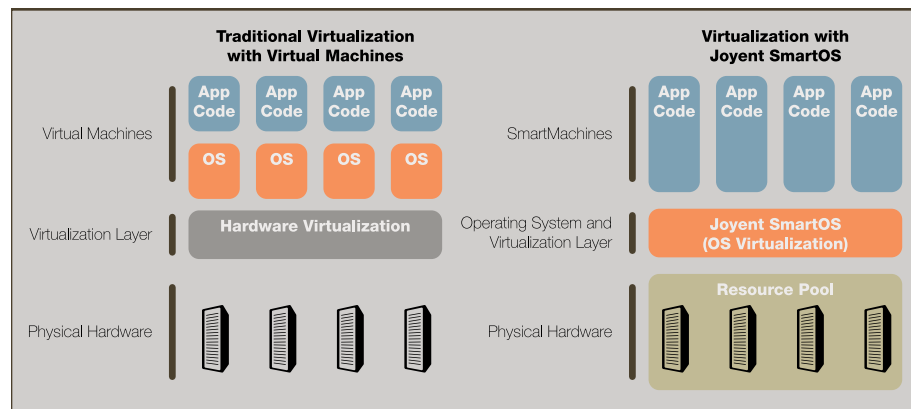
Joyent SmartMachines

The Smartest Virtual Machine

Joyent SmartMachine is a next generation virtual server perfectly optimized and designed for operation in a virtual data center. Rather than emulate a hardware layer like legacy virtual machines (eg. provide a full operating system to every customer with the consequent inefficiency), each SmartMachine uses SmartOS for OS-level virtualization and comprises a virtual container using a shared kernel. OS level virtualization removes a layer of abstraction and dramatically increases potential capacity and throughput per physical server while also reducing management complexity for customers and data center operators.

This more direct approach to accessing compute resources gives SmartMachine's CPU performance up to a five time advantage over

other cloud providers, according to industry benchmarking.[1] At the hardware level, a Joyent SmartMachine loaded with SmartOS better utilizes physical CPU cores and memory. The bottom line? A data center operator using Joyent SmartMachines can deploy two to three times as many virtual servers per CPU core as legacy, hardware virtualization providers.

The Joyent SmartMachine abstracts hardware more efficiently than conventional VM architectures, presenting a pool of hardware resources rather than resource slices.

For operators who serve customers with applications that use legacy operating systems such as BSD, Linux or Windows, Joyent Virtual Machines use the KVM and VDI standards on top of the Joyent SmartKernel, which is instrumented with real-time, fully introspected Cloud Analytics and Telemetry.

Unlike other virtual servers, SmartMachines provide access to a shared pool of compute resources to users and operators. This dynamic resource sharing capability allows operators and customers to engage in either fine-grained or massive vertical and horizontal scaling available on-demand. The SmartMachine also allows shared virtual server management. For customers, Joyent SmartMachines deliver cost savings through reduced management overhead and higher capacity per virtual server. Also, true vertical scaling gives customers peace of

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1 Joyent SmartOS SmartMachine Benchmark Results Summary, **http://bit.ly/JoyentResources**

mind by providing "viral event insurance", for example when a link to a video gets posted on TechCrunch, a shopping deal on Gilt.com gets massive traffic, or a newly launched social game gets a much more enthusiastic response than anticipated. Unlike other virtual data centers that require users to provision new virtual servers when virtual machine capacity is maxed out, Joyent has designed SmartMachines to handle rapid increases (either short-term or sustained) of processing activity by tapping the shared resource pool. This 'burstability" is unique in the virtual data center universe and is a key differentiator for users seeking confidence that their Web applications will always remain available.

The Green Cloud: Shared Resources, Better Utilization, Less Power Usage, Higher Profitability.

For operators, Joyent SmartMachine delivers cost savings through reduced management overhead, reduced hardware costs due to higher compute, storage and networking utilization per CPU core and physical server, and therefore reduced physical space and power demands. Ultimately, this helps operators increase revenue per-square-foot, enhance operating margins, maintain Quality of Service (QoS) standards and and raise customer satisfaction in a true win-win scenario (for both providers and customers).

Command and Control

It's All About the APIs

Plain and simple, application programming interfaces (APIs) have become the accepted way to import and export data streams from one program or operating environment to another. For SmartDataCenter, Joyent built pervasive and robust RESTful API hooks that allow an operator managing a cloud virtual data center to quickly and easily set up a management console for all critical parameters from server management to telemetry to virtual OS layer to application layer for

customers. The use of these APIs ensures easy replication and mirroring of control panel views for both operators and customers, providing either the capability to build customized control panels or the ability to create shared views that ensure customers and operators are always looking at the same information and speaking the same language. Out of the box, Joyent SmartDataCenter offers a thin-client user interface that is highly configurable due to the flexibility and ubiquity of the underlying API-driven data feeds. Or they may elect to export virtual data center operations information into third party analytics packages or build their own user interface.
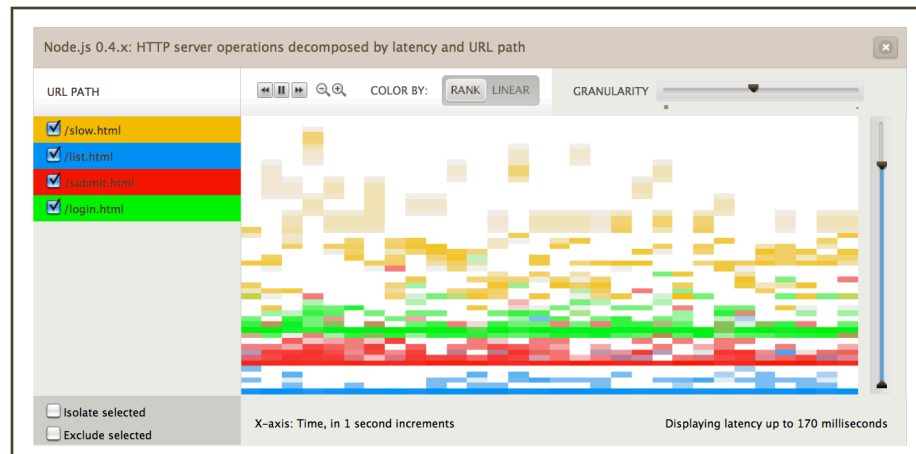
Joyent SmartDataCenter's Cloud Analytics:

Visualize 4,000 Different Parameters from One User Interface
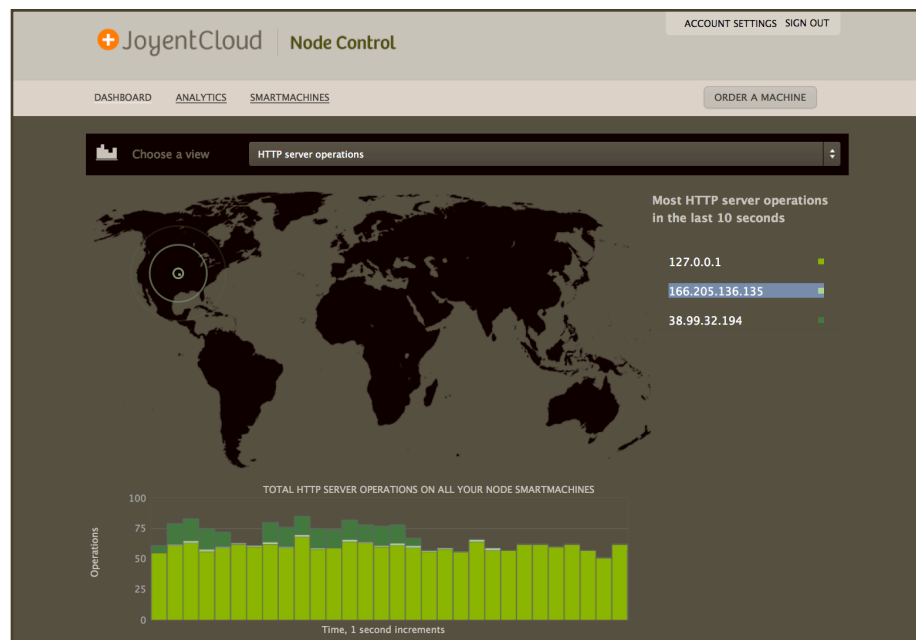
Joyent's Node Control offers a comprehensible visual overview for users of the No.de service.

Analytics in the cloud are usually complicated and clunky. Troubleshooting for both the service provider and client is time consuming and difficult due to the incredibly fluid nature of cloud environments and the higher degrees of application complexity in

virtualized environments. Joyent SmartDataCenter employs DTrace, an award-winning dynamic tracing framework, to enable Joyent Cloud Analytics to track more than 4,000 different parameters and activities up and down the Joyent SmartDataCenter software stack. This unprecedented visibility delivers equally unprecedented transparency without compromising simplicity or flexibility. Viewable parameters in Joyent Cloud Analytics include compute nodes, SmartMachine capacity and utilization, activity streams and requests – even down to latency performance for specific URLs or server calls. In addition, operators can use Joyent Cloud Analytics to manage Disk I/O, a useful mechanism for improving performance in a multi-tenant virtual data center that allows operator administrators to more easily isolate customers' processing tasks. Lastly, DTrace exerts no drag on performance so operators can perform full and continuous analytical queries in a production environment without worrying about increasing latency.

Heatmap visualizations like this can make it easy to spot patterns and outliers for key performance metrics like latency.

Unlike most data center analytics packages, Joyent Cloud Analytics capabilities enable operators to quickly investigate potential issues in specific Joyent SmartMachines, processes, applications or users with dynamic views that highlight not just averages but also outliers and obvious anomalies. Joyent Cloud Analytics includes easy-to-configure threshold monitoring and alerts to ensure that operators can monitor

critical events that may adversely impact the cloud data center and/or customers. Joyent SmartDataCenter also supports custom analytics through RESTful APIs that allow customers to define their own views, extend dynamic tracing to other parts of the application stack running on a Joyent SmartMachine, or export data streams to a third party analytics package.

Better Analytics Equals Better Business Value

The granularity of Joyent Cloud Analytics allows data center operators to more easily maintain Quality of Service and to police their own SLAs through comprehensive reporting both for internal and external audiences. The visual tools of Joyent Cloud Analytics enable fast troubleshooting that dramatically reduces man-hours spent on a per case basis. This capability reduces operator OpEx and increases data center profitability while delivering excellent performance to customers.

Joyent Cloud Operator Portal

A Flexible, Customizable, Visual Control Room

Operating a cloud environment brings unique challenges in provisioning, billing, and network management. Joyent SmartDataCenter's Cloud Operator Portal gives virtual data center operators a simple unified tool for managing all aspects of their cloud or integrating outputs to other tools such as OSS/BSS or A/R programs. Provisioning in the cloud entails down to the minute accounting and flexibility requirements unheard of in the physical co-location world. The Joyent Cloud Operator Portal, a thin-client UI built atop the API plumbing of the Joyent SmartDataCenter, gives operators the ability to finely control customer and internal deployments of SmartMachine configurations and software packages dependent on data center location, application types, and customer status. All of this control comes with the same customizable visual UI building layer that operators can use to build their own visual control room.
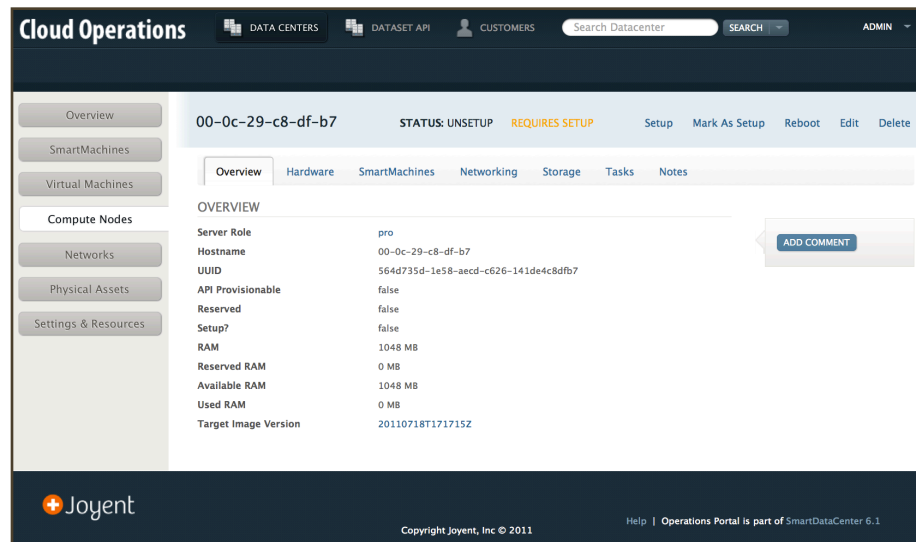
The browser-based interface for SmartDataCenter allows for easy management of resources and customers from almost any device.

With the Joyent Cloud Operator Portal, the operator (and, if permitted, the customer) can add new application packages in a single step from a simple GUI menu. Cloud service providers can tap into SmartDataCenter's configuration tools, as well, to offer simple self-service options to new and existing users. Customer administrators can, in a matter of minutes, order a new SmartMachine, configure that machine with datasets offered by Joyent (eg. SmartOS, Node), and set up access privileges using the familiar pull-down UI. On the back end, Operators can quickly add or deselect new datasets to be offered to customers, or customize dataset offerings to customers based on key parameters such as duration of relationship, number of SmartMachines running, and other trust-based metrics.

Ready Export of Billing Information Completes the Total Cloud Package

Billing in the cloud requires the ability to capture a wide variety of metrics that may fluctuate by the minute or by the hour from virtual machines located in disparate geographies. Joyent Cloud Billing, a subset of the Joyent Operator Portal, allows for virtual data center operators to easily export all the data required for proper customer billing into third party A/R and BSS/OSS and ERP packages such as

those from SAP, Oracle and Amdocs. Because Cloud Billing taps into the same finely-grained data capture that powers Joyent Cloud Analytics, virtual data center operators can build detailed billing rules structures to fit their specific needs and to match specific customer offerings.

Enablement Programs Ensure Rapid Time To Market

To ensure that operators can get up and running with SmartDataCenter rapidly and profitably, Joyent offers both technical and business professional services that are based on Joyent's six years of experience providing public cloud services to enterprises:

- **Basic Enablement Program** improves time to market with programmatic, packaged sales and marketing campaigns.
- **Premium Enablement Program** delivers onsite hands-on business and technical consulting to jump start cloud initiatives.
- **Deluxe Enablement Program** provides dedicated senior business and technical resources to augment Service Provider internal teams.

Joyent SmartDataCenter

Built for Operators. Easy to Maintain. Easy to Manage. Highly Profitable. Highly Secure.

Joyent SmartDataCenter is a comprehensive cloud software infrastructure platform for service providers to operate a profitable, high-performance, drama-free cloud. From security to scalability to visibility and ease of management and self-provisioning, Joyent SmartDataCenter was developed specifically to make the task of building and running a virtual data center far easier and far more profitable for operators.

For more information about SmartDataCenter and Joyent, please visit www.joyent.com.