



## WHITE PAPER

# Oracle Linux: Engineered into a Business-Class Solution

Sponsored by: Oracle Corp.

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## EXECUTIVE SUMMARY

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As the second most widely deployed operating system (OS) today, Linux carries a number of advantages in a world heading toward next-generation deployments and increasing adoption of cloud-based solutions. Customers today are looking at higher levels of standardization beyond just the hardware and operating system layers as a way to support a wide variety of business workloads, ranging from database and commercial applications to infrastructure and Web-serving tasks. These customers are increasingly receptive to deploying virtualized solutions that empower them to make consistent, repeatable deployments that can be brought online quickly and efficiently in both in-house and platform-as-a-service (PaaS) environments while being configured for resiliency and performance.

This increased integration begins with system infrastructure software, where operating system software solutions are increasingly being closely packaged with virtualization and virtualization management tools. These packages in turn create a software stack that can be used consistently across internal and external deployments. It is this standardization that generates value for customers by simplifying the process for installation and configuration of new systems. It is clear that virtualization and cloud computing are helping change the rules in infrastructure software and application software deployments.

There are several key elements that are helping power this shift: the increasingly dominant position of the x86 platform (and the operating systems that run aboard x86 hardware), the maturation of x86 virtualization, and the management tools surrounding these solutions. The broad acceptance of x86 servers, particularly after the launch of servers based on the Intel Xeon 7500, Xeon 5600, and AMD Opteron processors, helps create a strong foundation for operating systems that can take advantage of this modern hardware architecture. Today, there are three operating systems that can be considered viable aboard x86 hardware: Linux, Windows, and Unix. Of those, each has unique attributes that position it for success in the future. Linux is best known for bringing attributes that historically were associated with Unix – scalability, reliability, and portability – to the x86 architecture in a low-cost, easy-to-consume form factor.

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IDC is seeing a resurgence of close integration between hardware and software from a number of vendors, including Oracle Corp. In the case of Oracle, its approach to engineered systems and standardized software offerings with Oracle VM Templates and its turnkey hardware solutions in Oracle Exalogic, Oracle Exadata, and Oracle Virtual Compute Appliance are in synchronization with the trend of customers beginning to factor cloud computing into their future internal road maps. The endgame is to differentiate and deliver value through better up-front integration, reducing the time to deployment for customers.

## IN THIS WHITE PAPER

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This IDC white paper considers the evolution of Linux as a solution for business workload deployment and how vendors are taking an increasingly integrated approach to Linux solutions.

This white paper considers the new ways in which Linux is being delivered to customers in response to the changing datacenter requirements and the increasingly favorable view on preintegrated solutions across the industry today.

## SITUATION OVERVIEW

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### The Changing Nature of the Market

Through the past 20 years, the computer industry has experienced waves of change caused at times by economic disruptions and at times by technology evolution – and frequently by a combination of both factors. An argument can be made that each industry shift causes a sustained, usually permanent, change to the trajectory of the hardware market. And with each new wave of industry growth, the new software solutions gain traction and begin to set the stage for future waves of technology evolution, adoption and – of course – disruption.

The 1990s saw the heyday of Unix/RISC servers, which were the solution of choice for supporting emerging Web-based workloads necessitated by the e-commerce and online services made possible through mainstream availability of the Internet, which in turn helped create the massive dot-com boom. In addition, during the 1990s, Windows Server emerged as a volume product that helped propel the x86 server market from what was seen as a (barely) low-end solution in the early 1990s to an increasingly viable solution by the late 1990s, useful for commercial workloads that were considered important – but not necessarily mission critical.

The rise of the x86 architecture helped nurture the development of Linux, which emerged as a fledgling but commercial product in the late 1990s (see Figure 1). The dot-com bust that happened in the early 2000s set the stage for Linux (and associated open source-layered software) to firmly establish itself as a viable alternative to Unix and Windows, particularly for Web- and infrastructure-oriented workloads.

Success was achieved with these workloads initially because Linux offered a low- or no-cost solution that not only was compelling but also helped address the tight budget restrictions placed on IT departments during the recession that followed the dot-com bust. It was here that Linux proved to

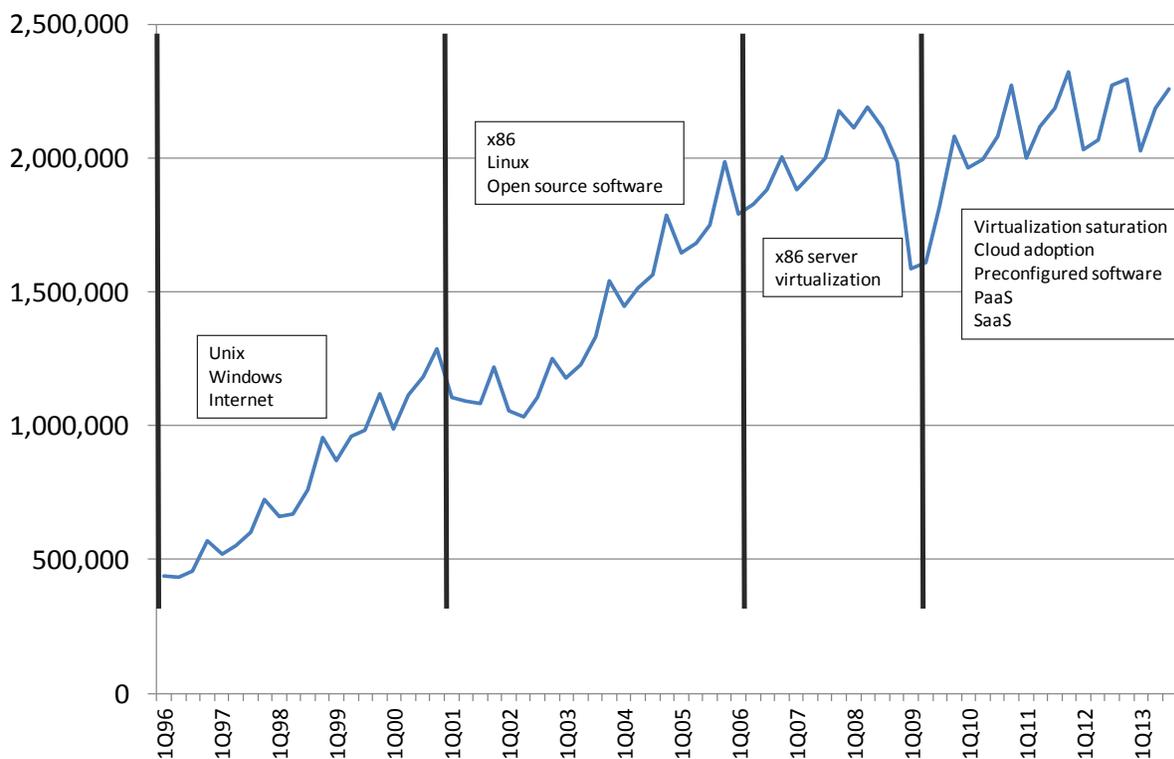
customers that it was more than just effective; it proved to customers it brought attributes including good performance, reliability, and a strong price/performance story. It was the establishment of that credibility that allowed Linux to later move upmarket into commercial environments where paid subscriptions are the norm. Mission-critical workloads running on commercial Linux distributions are now commonplace.

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As noted on Figure 1, recent industry transitions are changing the nature of the game for operating systems, as physical server shipment growth has flattened off, caused by virtual machine (VM) growth made possible by x86 virtualization software. IDC expects increasing saturation of the penetration of virtualization software, but the virtual machine density aboard virtualized servers will continue to grow. These trends are being driven both by on-premise virtualization and private cloud and by shared public cloud deployments.

**FIGURE 1**

**Worldwide New Physical Server Shipments, 1996-2013**



Source: IDC, 2014

## Workload Shifts and Industry Change

Today, Linux not only is considered a mainstream solution for general-purpose workloads but also has established itself as a potent player that addresses many high-end market opportunities and newly emerging opportunities, including:

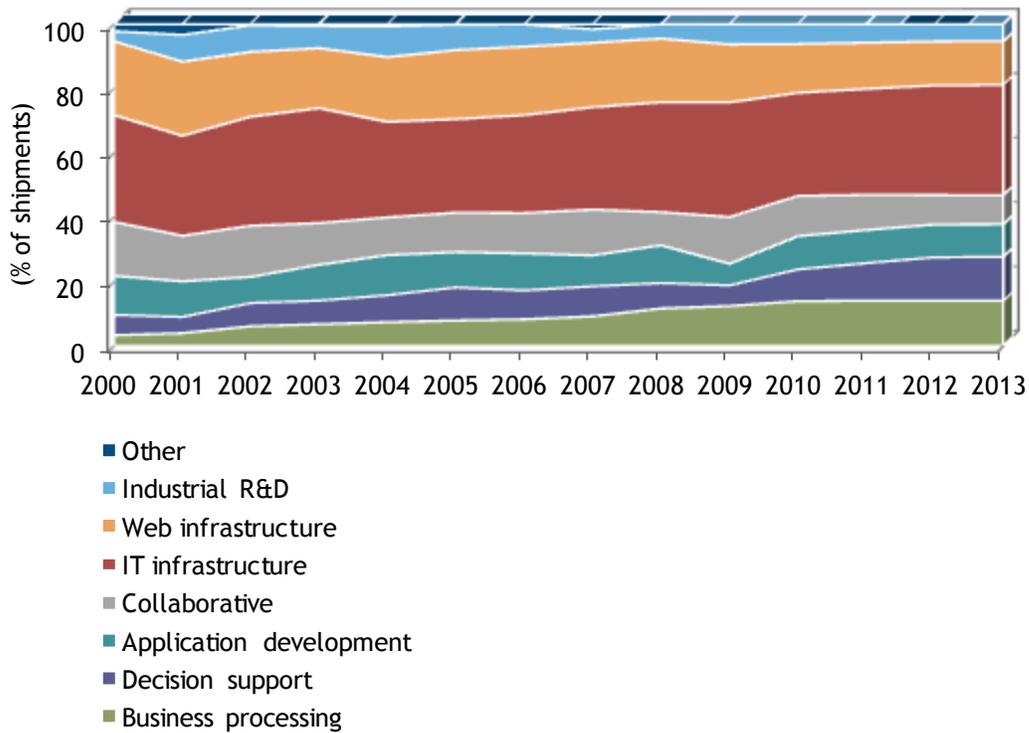
- **Web and network infrastructure servers.** Linux long ago established itself as the leading player in the Web workload space and has successfully displaced Unix and Windows in this workload segment. While Web workloads are contracting in share of total Linux workloads because of growth in the overall Linux market, the overall unit volume of Web workloads continues to grow in absolute numbers (see Figure 2).
- **As a platform for commercial workloads.** This workload area is one of the larger growth areas for Linux, particularly as increasingly high-end Unix/RISC solutions are moving over to x86 servers and the Linux operating system. As noted in Figure 2, the percentage of business processing applications deployed on Linux grew from 3.3% in 2000 to 14% in 2013, while the percentage of decision support workloads more than doubled in that same time frame. The percentage of both business processing and decision support workloads deployed on Linux grew from 19.6% in 2008 to 27.7% in 2013. This growth is compounded when measured in overall unit volume since new Linux subscriptions have also increased dramatically through this period.
- **High-performance computing (HPC) solutions.** Linux has successfully become the superstar of the HPC industry. Over the past several years, it has all but driven Unix out of the market as a viable solution aboard x86 HPC hardware, and today, it holds in excess of 90% market share aboard HPC installations of all types.
- **Ultra-low-end deployments.** Long used in small form factor hardware appliances, Linux has become a favorite in this market space because of the relative simplicity of starting from the mainstream kernel and paring down a kernel that includes only the needed services for a given single-function solution. Commonly used as the engine for security devices and storage devices, Linux has driven down the use of one-off operating system solutions. Today's emerging density-optimized x86 servers and the forthcoming ARM-based servers are two places where Linux may be the primary operating system solution.
- **As a foundation for software appliances.** This emerging category of system infrastructure software, including the Linux operating system that is tightly integrated with application solutions, today most commonly uses Linux as the foundation layer. Several commercial initiatives offering tools enabling ISVs to build Linux-based software appliances have come to market.
- **As a multi-architectural solution.** Today, Linux has been ported to every major architecture in commercial use, ranging from CISC mainframe systems to RISC and x86 processors to low-end ARM and Atom processors. Linux has been particularly successful in the mobile and embedded space, which is setting the stage for next-generation server workloads that will support those mobile devices. In many cases, having direct compatibility between client devices (of all form factors) and the supporting server operating system on the back end is a benefit and can be a competitive differentiator.

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- **Server virtualization.** Because of the relative caution that customers historically used when deploying x86 servers, machines were typically overprovisioned and underutilized, creating a ripe market opportunity for enterprise virtualization software to be deployed aboard x86 servers, an opportunity that was exploited by early market entrants such as VMware. Over time, most of the major OSs integrated hypervisors, including Linux with Xen and KVM (Kernel-Based Virtual Machine).

**FIGURE 2**

**Linux Workload Evolution, 2000-2013**



Note: Data is from IDC's 2013 workloads multiclient study.

Source: IDC, 2014

## Linux in the Market

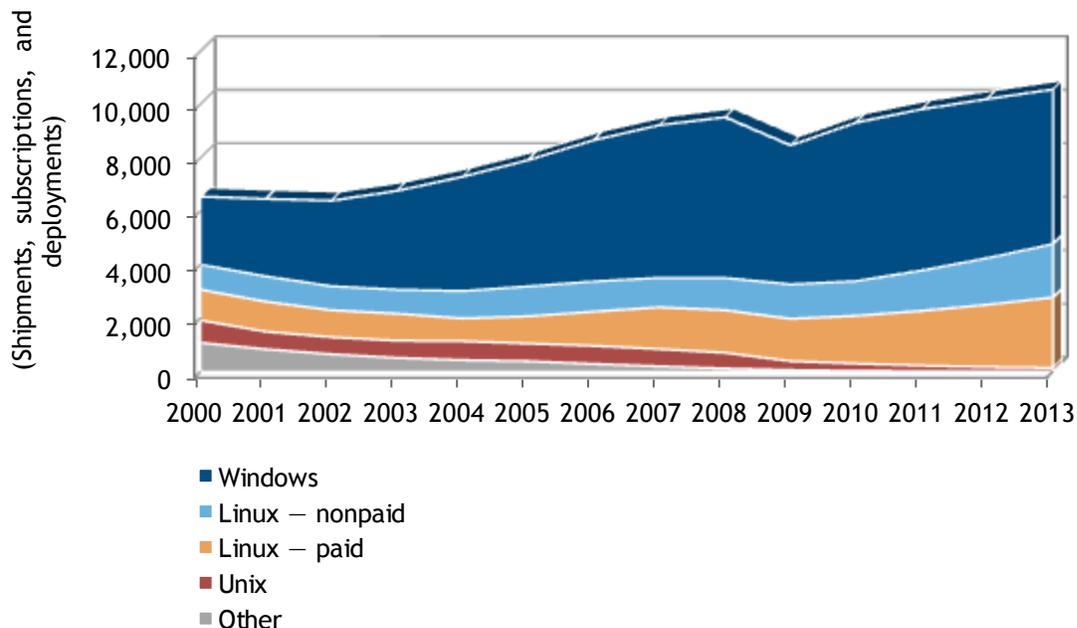
Figure 3 presents the overall unit volume for new license shipments, subscriptions, and deployments of nonpaid server operating system products on a worldwide basis. As noted in Figure 3, when including all Linux deployments (including virtualized deployments of independent copies, but excluding replica copies, and nonpaid deployments [which often are deployed on recycled or redeployed hardware]), Linux captures 40% of new server OS deployments today.

IDC estimates Linux's market share will grow on physical servers because of demographic shifts caused by higher rates of virtualization on Windows servers. However, when considered on the base of total instances, Windows will remain a formidable competitor on the server side of the market.

Linux today is remarkably successful in capturing Unix migrations being completed by enterprise customers, splitting those opportunities about equally with Windows. In addition, organic growth of existing Linux server farms by commercial customers helps add to this growth. We believe all the future growth in the market will go primarily to Linux and Windows.

### FIGURE 3

**Worldwide Server Operating Environment New License Shipments, Subscriptions, and Nonpaid Deployments, 2000-2011 (000)**



Source: IDC, 2014

## Managing Linux Moving Forward

Managing the growth and evolution of Linux is not a standalone challenge; it is actually one dimension of what today is an increasingly complex and interrelated set of management challenges. IDC sees several trends that compound one another within customer datacenters today:

- **A drive toward system standardization.** Diversity breeds complexity, and complexity leads to higher support costs. Organizations today are realizing the benefit of standardization at as many layers as possible within their datacenter, which is driven at the lowest level by an effort to consolidate aboard x86 hardware and, increasingly, a common virtualization layer aboard that hardware. Having a standard hardware architecture leads to lower support contract costs, greater interchangeability of systems, a smaller parts inventory to maintain, and a reduced number of systems to educate staff about. Typically, organizations that are standardizing their hardware infrastructure also use a standardized virtual environment, which bridges any remaining hardware inconsistency. One additional benefit to maintaining a standard hardware and virtualization configuration is a vastly simplified disaster recovery challenge.
- **Operating environment standardization.** Having the smallest number of operating system versions and configuration permutations above the hardware and the virtualization layer is the ultimate objective. The end result of greater consistency leads to a reduced test matrix and support matrix – and a smaller inventory of skills needed to support those configurations.
- **Standardization above the operating system.** Of course, standardization for the upper stack and application layers has a similar benefit to that offered by OS and system standardization: a reduced support matrix to maintain.
- **Virtual machine sprawl.** Offsetting the initiative to reduce the number of unique system configurations is the explosion of operating systems aboard today's virtualized infrastructure. Because of the ease of replicating virtualized stacks of software, customers generally find that the aftermath of a virtualization migration is a reduction of hardware footprints but a static – or growing – operating environment inventory.
- **Preparing for cloud computing.** While IDC sees cloud computing as a revolutionary technology that will be adopted in an evolutionary manner, customers need to adjust their internal road maps for a long-term transition that includes the use of solutions that will provide a smooth migration path to cloud. This can come from software configuration planning, from updated application design, and through deploying the right hardware/software stacks that will allow an extension to a cloud-based computing scenario over the longer term. Most larger customers are expected to experiment with private cloud and hybrid cloud scenarios before making a wholesale commitment to a pure public cloud deployment for important applications and workloads.

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## Addressing Linux Growth

As discussed in the previous section, customers are becoming increasingly favorable to using deployment scenarios that support consistent deployments based on one of several standardization layers. Linux vendors are still adding value for Linux customers by integrating a substantial list of

value-added solutions that increase the effectiveness of and ease of deployment and ease of operation for the Linux products. Those solutions include:

- Clustering and high-availability tools
- Virtualization
- Advanced management tools
- Integration and support for the latest storage and networking peripherals
- Enhanced security
- Support and optimization for applications
- More robust development environments and tools

## A Look at Oracle's Linux Product Stack

A good example of how vendors can differentiate themselves in a market where the core technology is open source – and therefore not a big differentiation – is what Oracle has done with its commercial distribution. Oracle's work starts with the mainline Linux code base, like all other Linux distribution providers. But the company then integrates value-added technologies such as Ksplice and DTrace with the Linux kernel to give customers a better consolidated product designed for commercial deployments. This gives Oracle both a competitive story and a measurable differentiation.

Oracle has long maintained a focus on delivering deployment-ready software that minimizes the complexity and time required for setup and initial configuration. While the company applies that approach to core open source system software technologies through Oracle Linux and Oracle VM, it also applies that same approach to higher levels of software through its use of Oracle VM Templates and Oracle Virtual Assemblies.

Oracle VM Templates are effectively preconfigured stacks of software that minimize the installation and configuration process for enterprise customers. More specifically, an Oracle VM Template is a virtual machine, or a group of VMs, containing Oracle or other software that is prebuilt, preinstalled, preconfigured, and ready to use and typically requires little or no installation. An Oracle Virtual Assembly is made up of a user-defined combination of one VM or multiple VMs containing an entire topology of a multitier application including deployment and management directives.

Oracle VM Templates offer the benefit of an integrated software stack that is configured and supported by a single vendor. Having a single vendor take responsibility for the whole stack ensures that each release will be pretested, and users will not be forced into making selective deployment decisions based on compatibility or interoperability between components. This approach vastly simplifies life-cycle management for customers and can partially or totally eliminate the need to perform customer-conducted regression testing at the time of application update, fix, or patch and service package releases.

IDC notes that some open source purists frown on the integration of proprietary code such as Ksplice and DTrace with an open source technology, since the resulting solution remains in its entirety a unique solution that is not able to be duplicated directly by the community or competitors. IDC

understands this point of view but believes that the integration of value-added solutions makes the overall solution stronger. There is some degree of lock-in with every technology that is deployed. In the case of offering value-add as Oracle is doing, customers are able to make an objective decision as to whether they want to subscribe to a Linux-based solution that includes – or does not include – these sorts of value-added solutions.

## *Oracle's Approach to Its Linux Products*

Oracle has been in market with solutions on the Linux platform since the late 1990s and, in 2006, launched its own Linux distribution. The company continues to offer a subscription support program for customers that had originally installed Red Hat Enterprise Linux using Oracle's Unbreakable Linux Network. Under this program, customers receive their updates and patches from Oracle. In addition, the company has also applied considerable effort to build its own technology-differentiated distribution.

The initial entry by Oracle into the Linux support business was partly driven by its interest in streamlining the support complexity for its enterprise customers, many of which were receptive to reducing the number of different vendors that needed to be contacted in the event of a compatibility issue between the application software and operating system layers. Oracle also wanted to have direct control over how quickly patches would be developed and made available to address issues related to Oracle database and middleware products.

Given Oracle's preexisting focus on large and midsize enterprise customers (where Oracle's other products have typically been most successful), it is no surprise that the company's initial success with Linux was among larger existing Oracle accounts.

In September 2010, Oracle took its initiative one step further and brought out its own unique Linux kernel. Oracle's Unbreakable Enterprise Kernel (UEK) includes features unique to the Oracle Linux product but retains binary compatibility with Red Hat Enterprise Linux. That release incorporated additional optimizations designed to support large servers with improved power management, a fine-grained CPU, and memory resource control. Oracle's effort focused on ensuring optimal scalability with support for up to eight-core processors and demanding workloads such as large Oracle applications and database instances.

Since that time, Oracle has continued to add differentiation to its Linux solution with Unbreakable Enterprise Kernel. Currently at Release 3, the Unbreakable Enterprise Kernel is based on the mainline Linux kernel version 3.8.13. Oracle's Oracle Linux Unbreakable Enterprise Kernel is delivered with DTrace support (which no longer requires booting into a separate kernel because of full integration), performance and scalability improvements for systems with large memory and large core counts, and an improved Btrfs (file system). The company has continued to enhance virtualization performance in conjunction with Oracle VM virtualization technology. The new release also includes support for Microsoft virtualization environments (more on this topic later in this white paper).

IDC notes that Oracle continues to offer a Red Hat-compatible version of the kernel, and customers that download or subscribe to Oracle Linux have the choice to deploy the kernel that best serves their specific needs.

Oracle has integrated other enterprise-oriented technologies into its Unbreakable Enterprise Kernel Release 3, including the DTrace technology that originated in Solaris. DTrace offers tracing capability for the kernel, systems libraries, and applications. Another technology that is new is Linux Containers. While this technology is included in the mainline Linux kernel today, Oracle was one of the first companies to support it commercially.

One feature offered in Oracle Linux specifically to customers with Premium Support subscriptions is Ksplice, a technology that makes it possible to make kernel updates with significantly reduced (or eliminated) planned downtime. This technology is often positioned as a security feature because it allows users to promptly install kernel patches, reducing potential vulnerabilities of the Linux kernel. The Ksplice technology can be used both with the Unbreakable Enterprise Kernel and by customers that are using the Red Hat Enterprise Linux-compatible kernel.

Of particular note for Oracle Linux customers is an agreement that Oracle signed with Microsoft in 2013 that makes it possible to subscribe to an Oracle Database instance in a Windows Azure environment. However, the agreement went well beyond that one headline dimension, with Microsoft adding Oracle Linux to its catalog of preconfigured operating systems (and, in the process, Oracle Linux becoming the fifth Linux distribution to be offered on the Windows Azure cloud). This agreement shows how cloud computing breaks down old barriers and establishes both new competitive fields and new alliances previously thought to be unlikely or impossible.

Oracle Linux tracks Linux mainline on a 12- to 18-month cadence, allowing the company to bring new Linux features into commercial implementation relatively quickly. Oracle has taken a multifaceted approach to supporting Linux, and in addition to its commercially supported offerings, the company also offers free download of executable code and patches for Oracle Linux, free errata, bug fixes, and security updates – in addition to the GPL-mandated source code download. This means that customers have the choice to deploy Oracle Linux and pay for a support subscription on servers where it is warranted and to use the same product on other servers without a support subscription when and where it makes good business sense. All competitive Linux vendors offer source code downloads, but only a few vendors offer executable code with perpetual use rights.

### ***Oracle VM and Oracle VM Manager***

Oracle has consistently invested in a Xen-based hypervisor with its Oracle VM product. There are parallels between Oracle's approach and justification for directly supporting Linux and Oracle's approach to build out a virtualization platform – in particular, the benefits associated with tightly integrating system software with management tools and applications – and deliver and support that integrated stack.

Just as Oracle concluded over time that it could deliver a better application experience using a more integrated Linux solution built by Oracle, the company believes it can deliver a better, higher-performance, and more reliable solution for its entire software stack through the inclusion of a hypervisor optimized for deep stacks of Oracle infrastructure, middleware, database, and application software.

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The base Oracle VM product is a free server virtualization product that offers support for competitive operating systems including Windows Server 2012. Oracle also offers a management product, Oracle VM Manager, as part of the Oracle VM 3.2 package. The management solution is available for free, although Oracle encourages customers to consider upgrading to the Oracle Enterprise Manager solution, which adds hardware management support to the Oracle VM Manager resources.

The latest version of Oracle VM, under release 3.2, offers numerous improvements, the majority of them rendering in the Oracle VM Manager solution. Some of the key enhancements are:

- Integration of management for SPARC and x86 server virtualization and operating systems
- New management features covering health monitoring, cluster time-out controls, and network control features
- The ability to send messages to individual VMs (guests) to create custom configurations inside the VM, and the inclusion of a serial console Java applet that allows access to the console of VMs running on both x86 and SPARC hardware
- Better placement of VMs on start-up and support for larger server pools and bigger servers

IDC notes that the Xen hypervisor remains the third most widely used hypervisor in the market, despite the introduction of KVM into the Linux mainline code base. Xen continues to be a favored solution in some industry segments, including the hosting market. Oracle and Citrix are two of the key commercial contributors to the Xen open source project today. Worth noting is that while Oracle does formally support KVM, as it is integral in the Oracle Linux operating system, at this time, the company has chosen to not certify its layered software for use aboard KVM.

### *Integrated Technology: The Oracle Differentiation*

Operating systems such as Oracle Linux don't operate in a vacuum. Operating systems commonly interact with other system infrastructure software layers, including the hypervisor below them, availability software and systems management software located adjacent to the operating system, and applications installed on top of them.

Oracle has long carried a philosophy of offering a complete package that requires relatively little (or potentially no) customization work at installation, leading to a faster return on investment. As a result of this focus, the company has been driving toward a complete stack of software solutions, ranging from system software to applications, that can offer unique benefits. These related products include the following:

- **Application to hypervisor end-to-end management.** Oracle has built out a stack of management tools that today allow the company to manage all layers of the stack, starting at the operating system, moving up through the middleware and database layers, and finally ending up right at the application software stack. This allows former Sun customers and customers using non-Oracle hardware to have a unified management experience from a single pane of glass. Oracle Enterprise Manager 12c delivers Linux operating system provisioning, patching, monitoring, and administration capabilities via a single Web-based user interface – the same tool can also be used to manage the Oracle application stack. Using these management tools, customers get enterprise-scale service-level management, automated change and configuration management, and comprehensive system and application performance management.

- **Clustering for Linux.** Oracle also provides the key infrastructure software that completes the overall stack. Oracle Clusterware is a portable cluster software that allows the clustering of servers so that they cooperate as a single system. Oracle Clusterware also provides the required infrastructure for Oracle Real Application Clusters (RAC). Oracle Clusterware enables the protection of any application within a cluster, enabling those applications to be monitored and managed for high availability.
- **Unified management of RISC, x86, Solaris, and Linux.** Oracle has expanded its operating system suite far beyond Linux, and supports Linux on x86 servers and Solaris for x86 servers and SPARC servers, using Oracle Enterprise Manager 12c.
- **Integrated Linux software and Linux hardware.** Oracle is the only vendor in the industry today that both manufactures its own line of servers and delivers and supports its own Linux distribution.

## The Endgame: Oracle VM Templates and Engineered Systems

Oracle's vision ties together in the deployment: an engineered solution that ensures that all the pieces of the stack, ultimately, inclusive of the hardware layer, become a single solution that customers will adopt for the application solution delivered from the whole stack. IDC research has shown that tight integration can deliver unique benefits to customers, and as such, Oracle's approach differentiates the company's products in an otherwise increasingly commoditized hardware market.

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### *The Cloud Connection*

IDC believes that the shift to embrace cloud-compatible architectures has spawned changes in thinking in how datacenters are built and managed. The traditional datacenter is generally siloed in terms of compute, networking and storage, and even operating system and/or hypervisor. These silos are often built, extended, and managed separately.

The shift to the goal of a cloud datacenter requires much tighter integration and coordination between all these technology areas. Cloud is about unifying, abstracting, and delivering these resources as one service to the end user. Thus the industry has begun to develop converged and integrated systems such as the Oracle Exadata, Oracle Exalogic, and Oracle Virtual Compute Appliance machines – as well as integrated solutions from other vendors. These systems are complete units of hardware and software composed of compute, storage, networking, and operating system as well as middleware and, at times, applications.

The analog to software/hardware appliances being created by some large ISVs like Oracle (e.g., Oracle VM Templates, Oracle Exadata, Oracle Exalogic, and Oracle Virtual Compute Appliance) is the development of preengineered software-only solutions. When these items are integrated into a single cohesive unit, these types of systems aim to deliver the following benefits:

- **Certification of the entire stack.** Certification gives customers confidence that all the parts will not only work together but also perform optimally.

- **Version control streamlining.** With a single integrated solution, the burden is ensuring that an update to one layer of the stack – for instance, the operating system – will have no negative effects on other layers of the stack. If there is a negative effect, the software ISV can mitigate that effect by correcting the conflict at the other layer of the stack. In effect, one vendor takes full responsibility to certify and validate the entire stack.
- **Engineered systems.** An engineered system is a turnkey solution that helps ensure that a customer experiences a faster time to value. A preintegrated and fully certified hardware and software stack is quicker and easier to deploy, meaning customers get their application up and running quicker. Today, Oracle offers a range of engineered systems, most of which can run Oracle Linux.
- **Performance optimization.** Manufacturers of these systems can tune the entire hardware and software stack for a certain environment and even a single type of workload to maximize performance from a given set of resources.
- **Simplified management.** By certifying a converged set of hardware and software, management can be greatly simplified. Users don't have to construct systems from individual piece parts, which all need to be verified and tested and create a huge number of configuration permutations. Instead of users managing individual components and trying to unify and correlate that data, they can essentially manage the converged machine as a single unit.
- **One source for support.** Since the entire Oracle stack is delivered by a single vendor, customers don't have to work between multiple suppliers for problem resolution, and updates to one portion of the software stack are unlikely to cause conflicts in other levels of the stack.

## FUTURE OUTLOOK

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### The Shift to Virtualization and Cloud

System infrastructure software has seen great change in recent years because of the advent of server virtualization. Initially used for server consolidation, hypervisors have matured into a strategic role in the datacenter as the foundation for the dynamic, agile datacenter and as the foundation for some forms of cloud computing.

However, applications still don't run on hypervisors; they continue to run aboard operating systems, which in turn run on top of hypervisors. That said, the broad interest in using hypervisors has certainly had an impact on the role of the operating system and has triggered changes such as:

- **Optimization of operating systems for the virtual environment.** Operating systems have traditionally been tuned for maximum performance on the physical hardware they run on. With virtualization now the default scenario for most instance deployments, operating systems need to be as comfortable running on virtual hardware as not. Most operating systems vendors have done substantial work to ensure their operating systems perform optimally aboard hypervisors – always on their own hypervisors and often aboard competitors' products as well.
- **Virtual sprawl.** As the number of virtual servers has exploded, management of operating systems is now being conducted on a scale never before seen, requiring a shift to automated processes. With a shift to a more dynamic datacenter, where servers can be provisioned in minutes and new instances spun up to meet elastic demand, operating system configuration

management is essential and can take advantage of virtualization's golden image and cloning features. Today, management tools are evolving quickly to support an increasingly software-defined environment.

- **New deployment models.** Virtualization has also triggered new ways of software deployment such as the software appliance, an integrated stack of OS and application software. The OS in this role is tailored and optimized to run a single application, and the entire appliance is intended to be managed as a single entity.
- **Cloud adoption.** Virtually all customers are at least discussing what cloud computing will – or will not – mean for their current operations. IDC believes that different customer segments move to cloud in different ways. Enterprise and large organization customers are most likely to experiment with a private cloud first and dabble with a hybrid cloud deployment long before considering a full-blown public, multitenant cloud deployment.

Virtualization has also forced change across the rest of the datacenter, from storage and networking to people and processes. These areas have reinvented themselves in light of virtualization, adapting and optimizing not only for this new environment but also toward a larger goal of creating a cloud (private or public) that delivers IT as a service.

This shift toward cloud, which is an architectural change as well as a delivery model change, will have a lasting effect on all areas of the datacenter ecosystem for many years to come.

## CHALLENGES/OPPORTUNITIES

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IDC sees both challenges and opportunities for Oracle in the Linux market. The company has become a mainstream player, and the company's broad reach into enterprises is undeniable. Challenges and opportunities we see for customers include the following:

- **Oracle's perceived positioning.** Much of Oracle's product suite is positioned for large enterprises, although Oracle also has products it has acquired (such as the JD Edwards suite) that are focused on smaller and midsize organizations. In many cases, smaller customers with no experience with Oracle products may automatically look at competitive solutions offered by Linux pure-play vendors. For some customers, Oracle's low-cost Linux support subscription may be an attraction, but IDC believes the real value proposition from Oracle for end customers comes from the integration of its larger product portfolio.
- **Nonpaid Linux.** Every Linux vendor in the market is forced to compete with a nonpaid alternative that delivers most if not all of the same capabilities as the commercially supported alternative. In the case of Oracle, the company differentiates itself from most competitive Linux distributions by willingly offering the same product that is commercially supported for free use (in executable form) by customers as well. IDC notes that while the nonpaid Linux market represents a threat to Oracle – like for all other Linux distribution vendors – it also represents an enormous opportunity for customer acquisition. End-user organizations that are considering whether to use a commercially supported Linux or a free distribution should carefully consider factors such as the workload to be deployed on the server, what the long-term support plan is, and what the potential is for this particular workload to increase in overall

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scale or importance to the company before settling on a distribution choice. Only a couple distributions are available in the industry, including Oracle Linux, where nonpaid executable code can be deployed initially, and then without any reinstallation or migration, that same configuration can be moved under a commercial support agreement.

- **Selecting a hypervisor solution.** There are two major established competing hypervisor platforms in the market today, four minor players, and several other players. All the major and minor players continue to have ambition to become the core of the next-generation datacenter platform. While Oracle has significant clout in the middleware and applications space, some customers may have already made a hypervisor selection, and if that is not Oracle VM, customers could find themselves torn between the convenience of one-stop shopping and uniform support from Oracle and having consistency of infrastructure software in their datacenter. For customers not locked into a previous hypervisor choice, and for those receptive to using multiple hypervisors within their datacenter, Oracle VM should be a consideration since it is optimized for Oracle Database and Oracle middleware and applications.
- **Oracle database and applications customers.** Oracle currently has a large installed base of database, middleware, and application software customers aboard a variety of operating systems. These customers likely have a strong commitment to Oracle products and are likely to remain loyal to Oracle products in the future.
- **Unix solutions.** While the single-largest portion of the installed base of Unix servers are those running the Solaris operating system, there are a variety of Unix servers in use today, many of which are at a point where migration to an x86-based Linux server is a realistic possibility. IDC research suggests that the remaining Unix customers continue to be highly susceptible to migration – in part due to standardization efforts on Linux and x86 hardware. Customers using Unix servers today need to make a decision to either continue with Unix servers for some or all of the workloads they are supporting today or begin a long-term migration plan to move to next-generation platforms. This challenge is also an opportunity for Oracle since the company offers multiple solutions including Solaris (on both SPARC and x86) and Oracle Linux on x86.
- **Oracle's "total solution" approach.** IDC believes that the movement we see today toward turnkey engineered solutions is a natural next step as organizations try to transition into a private cloud and subsequently into a hybrid cloud model. Oracle's stack is arguably as well integrated in Oracle VM Templates and aboard Oracle's Exadata, Exalogic, and Virtual Compute Appliance servers as anything else available in the industry today. As customers seek to move to a cloud model, engineered systems from Oracle offer customers appealing blocks of preconfigured cloud computing that can be easier to deploy and manage and will likely have attractive operation cost metrics. Oracle has been moving quickly over the past two years to build out a cloud hosting business and has been accumulating and building the tools necessary to help a customer build a private cloud infrastructure. As customers begin to ramp their deployments of private and hybrid cloud solutions, we expect that the offerings in Oracle's portfolio will be seen as mature and convenient solutions.

**Customers using Unix servers today need to make a decision to either continue with Unix servers for some or all of the workloads they are supporting today or begin a long-term migration plan to move to next-generation platforms.**

## CONCLUSION

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The success of x86 as the volume architecture of choice for customers – and a move toward an increasingly standardized set of software layers for application deployment – works in favor of a company such as Oracle. The increasingly dominant position of the x86 platform today creates a strong foundation for operating systems that can take advantage of that hardware architecture. Today, there are three operating systems that can be considered viable aboard x86 hardware: Linux, Windows, and Unix.

Oracle's approach to engineered systems and standardized software offerings with Oracle VM built on Oracle Linux is in synchronization, with the trend of customers beginning to factor cloud computing into their internal road maps. As the only Linux distribution provider that is also a hardware OEM, Oracle has the capability to offer fully integrated and tested Linux systems.

This transition toward standardized architectures helps move customers to an environment that becomes easier and less expensive to manage, and it inherently makes these customers more ready to adopt a standardized cloud-based architecture when conditions are right for those customers. What is clear is that standardization generates value for customers by simplifying the process for installation and configuration for new systems, which helps differentiate for vendors and delivers value through better up-front integration for customers, helping them achieve value and benefits more quickly.

## CASE STUDY

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### The Progressive Approach to Linux Strategy

When you think of consumer insurance, the first thing that comes to mind might be the highly entertaining TV commercials that promote the leading vendors' services. While those commercials sometimes comically depict the justification for having insurance or cheerfully pitch the value proposition of the leading providers, those same commercials give little indication about the sophistication of the IT infrastructure that delivers the services behind those marketing pitches. In reality, a deep investment in IT powers the insurance industry so it is possible for insurers to help customers recover from losses ranging from minor automotive fender benders to devastating events caused by fire or weather. IDC interviewed Progressive Casualty Insurance Company – one of the major insurance companies that you have seen on television – about its use of Oracle Linux. The sections that follow describe Progressive's story.

#### *Enter Linux*

According to Progressive's lead systems engineer, who is responsible for developing IT strategies, fills solution architect roles, and oversees staffing the department with deep technical skills, Linux has become an important component of the organization's infrastructure since it saw initial deployment five to seven years ago. The Linux infrastructure was first used for classic edge-of-network workloads but evolved over time to take on increasingly sophisticated and critical workloads, and today it is a primary workhorse.

As in many organizations, Windows, with about 5,000 physical and virtual servers in use, still accounts for the largest overall volume. Meanwhile, Linux accounts for 180 physical and virtual servers, and an additional 150 physical and virtual Unix servers from multiple vendors round out the mix.

The bigger picture for Progressive, which has eased off of its previous bleeding-edge approach to technology adoption in favor of a leading-edge-of-mainstream adoption profile, is to continue a larger movement from Unix to Linux in parallel with a deepening of the commitment to an Oracle software stack.

Progressive's Unix-to-Linux migration is moving quickly now and is expected to wrap up soon – although there are more moving parts to that migration than might be immediately evident. The company has Oracle Database 10g deployments on Unix, and as those databases are redeployed on Oracle Linux, the database is upgraded to Oracle 11g. "We don't count it complete until both are done," notes the lead systems engineer.

Progressive has two Linux platforms, with the first consisting of 115 x86 Linux instances running on VMware hypervisors, made up of 61 physical and 54 virtual machines. The rate of virtualization for Linux remains lower than that for Windows, a common scenario that IDC finds in the industry today. The remaining 75 Linux instances are supported on IBM z/VM servers. The mainframes are a carryover from the heavy dependence the insurance industry had on mainframes in the 1970s – a common companion platform IDC finds still in use among the insurance, banking, and other financial services industries.

### ***Oracle Enterprise Manager: A No-Brainer***

A couple of years ago, as Progressive's Linux investments were heating up, the company realized it needed to manage its Linux servers using the same best practices that are applied to other platforms, but the company did not have the BMC management agents necessary to support its Linux installations. After considering multiple options for management, the company decided the right approach was to shift its investment toward Oracle Enterprise Manager for a simple reason: The same management tool that the company used to manage its Oracle RAC installations could also manage its Linux infrastructure.

"We had experience with that product; it is included with the Linux management subscription, so it was a no-brainer. We have the OS, the database, the application, the Web layer, and the same management tool, and we have the same vendor. That is very powerful," explains the lead systems engineer.

Like many other Oracle Linux customers, Progressive began using Red Hat Enterprise Linux and made a broad decision to replace all its Linux installations with Oracle Linux. As part of this initiative, the company produced an Oracle Linux image and began testing it – in particular, the performance of Oracle databases, notes the lead systems engineer. "Late last year, when we were spinning up the infrastructure for the Oracle 11g infrastructure, we tested both the Oracle kernel and the Red Hat kernel. We got 15-20% better throughput on the Oracle kernel."

## *Ksplice: A Game Changer*

Progressive began with Oracle's standard-level support subscription, which was the same level of support the company previously purchased from Red Hat. However, the introduction of the Ksplice technology, which allows for applying Linux patches with no downtime, was a game changer for the organization. "So we targeted our development and production deployments – about 60% of our servers – for premier support," says the lead systems engineer. He notes that the support services dollars that used to be spent on Unix are used in part to pay for the premier support costs, with a net savings for the insurer overall.

Moving to Linux on x86 has not been without some sacrifices. These sacrifices include the integration, engineering, and one-stop shop for system support. The lead systems engineer states, "I could go buy an AIX pSeries, and that integration is done by IBM. Moving to Linux on x86, where we see struggles: You absorb that integration effort. For some organizations, it is not minimal. And it compounds given the mix of apps you have and can compound given the sensitivity those apps have to the physical server, kernel, etc. We are trying to minimize doing those one-offs."

## *Conclusion*

The lead systems engineer summarizes Progressive's experience, stating, "When I stack up Linux – and I have seen it for over 10 years – as the distributions go, [Oracle Linux] is a better engineered product. When you look at application guides, the way products are deployed, and validated configurations, Oracle has done a very good job of that. [And] Oracle has done a good job of validating hardware. We are very happy with the investments we have made." Of course, there is always room for some improvement, and he quips, "One thing I have asked Oracle about is the possibility of deploying Oracle Linux on the mainframe."

## About IDC

International Data Corporation (IDC) is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications and consumer technology markets. IDC helps IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy. More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide. For 50 years, IDC has provided strategic insights to help our clients achieve their key business objectives. IDC is a subsidiary of IDG, the world's leading technology media, research, and events company.

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