

White Paper

Enabling Enterprise Digital Transformation Using Oracle Linux

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IDC OPINION

Enterprises are increasingly adopting hybrid, public, and multicloud platforms to speed time to market while keeping their applications secure as they progress toward digital transformation (DX). IDC estimates that worldwide enterprise spend on public cloud infrastructure will surpass that of traditional IT infrastructure by 2022. Enterprises are also adopting modern application architectures and Agile development processes to bring products to the market faster. While public cloud platforms and modern application architectures provide scale and agility, they are not without challenges. Some enterprises lack the skill set and maturity to operate cloud-based and cloud-native platforms. Enterprises also find managing heterogeneous environments difficult. Operating system (OS) environments, being the foundation for digital transformation, can help mitigate these challenges by providing a common, standard platform.

IDC's research shows that Linux-based operating systems are the most used in public cloud environments. Enterprises have also started relying more upon commercial Linux distributions than open source distributions, as seen from IDC's operating system environment (OSE) Market Share studies. A commercial Linux distribution can help enterprises overcome the challenges of open source Linux distributions.

IDC recommends evaluating the right choice of commercial distribution based on the flexibility it enables, support for heterogeneous environments, type of support provided, and the application performance materialized. Leading commercial distributions such as Oracle Linux can make a significant impact on the digital transformation journeys of enterprises. The key differentiators for Oracle Linux include security, performance, flexibility, and choice; integrated tooling for better day 2 operations; support for heterogeneous applications; and one-stop shop for support.

This white paper discusses how operating systems provide the foundation for enterprise digital transformation and provides recommendations for selecting the right commercial operating system for IT buyers.

SITUATION OVERVIEW

Trends in Enterprise Business Applications

Enterprises are quickly adopting modern infrastructure paradigms such as cloud platforms, cloud-native technologies, and AI/machine learning (ML) technologies for their business-critical applications. According to a recent IDC study, workloads such as security, system management, and CRM are the

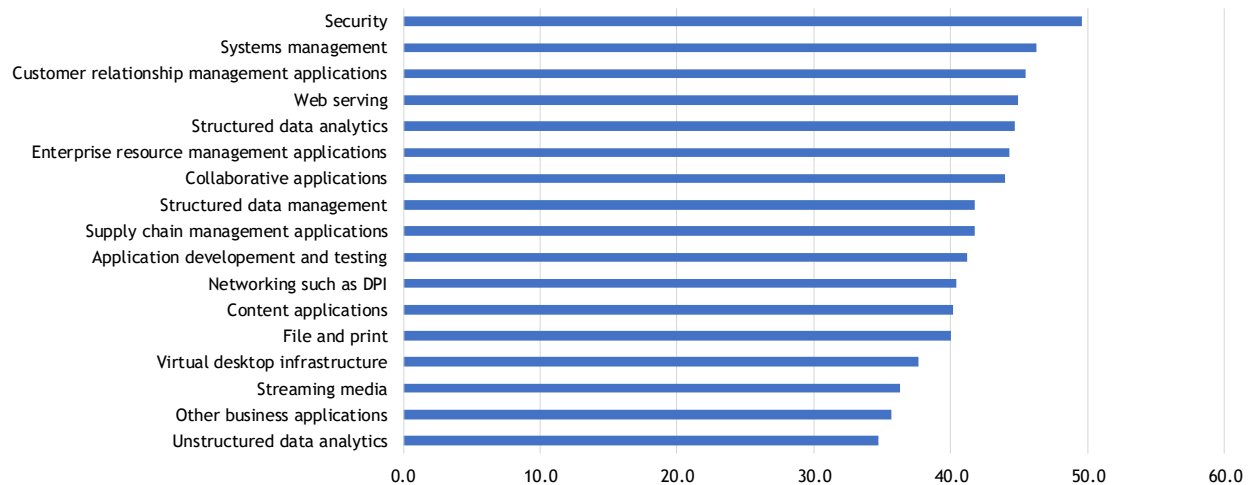
top 3 enterprise workloads to be migrated to public cloud infrastructure (see Figure 1). Most of the enterprise workloads that are getting migrated to the public cloud are being rehosted (commonly referred to as "lift and shift"), with scope for future optimization through application modernization techniques.

Notably, Windows-based workloads provide an opportunity for re-factoring/re-architecting using open source-based alternatives. For example, monolithic .NET applications can be re-factored to use .NET Core, thereby reducing the application footprint. Workloads can be either re-factored to use cloud-based services or re-architected into smaller components to run on Linux-based container environments.

FIGURE 1

Workload Migration to Public Cloud

Q. Among the workload types below, select all that you run on public cloud (IaaS and PaaS only) currently (2019) and those you expect to run on public cloud in 2020. Please exclude your SaaS and managed services.



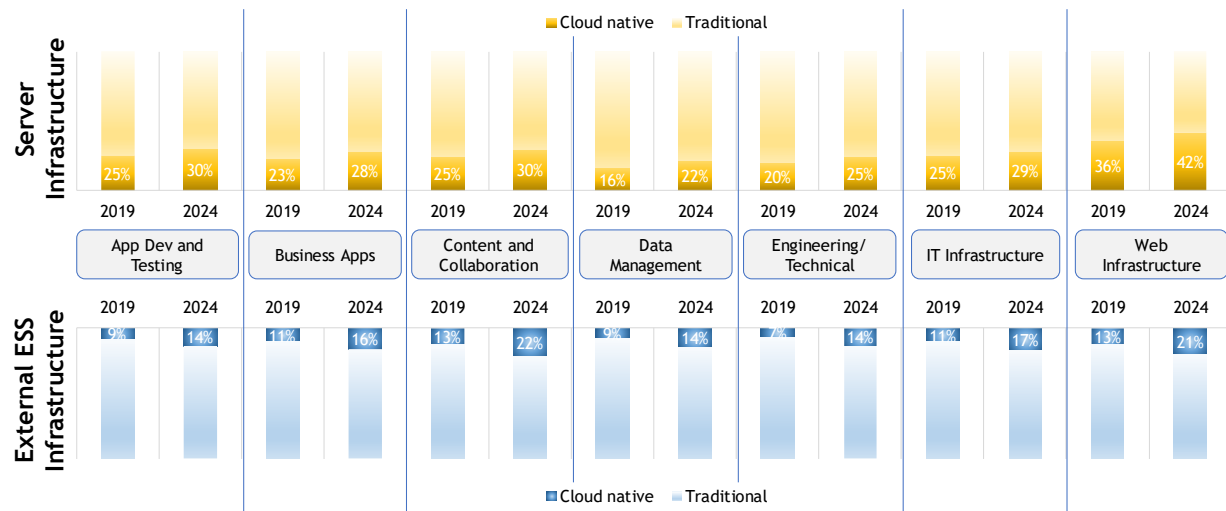
n = 510

Source: IDC's *Public Cloud Infrastructure Workloads Survey*, December 2019

Enterprises are also increasingly adopting modern architectural paradigms such as cloud-native architectures, microservices-based design, or low-code/no-code design for their business needs (see Figure 2). IDC predicts that by 2024, more than 40% of all categories of enterprise applications will be deployed on cloud-based infrastructure (see *Worldwide Server Workloads Forecast, 2020-2024: Investment Expands Despite the Ongoing Pandemic*, IDC #US46646020, July 2020). Most of these applications will be based on cloud-native technologies, microservices-based design, low-code/no-code paradigms, and next-generation applications.

FIGURE 2

Growth of Cloud-Native Applications



Note: For more details, see *Worldwide Server Workloads Forecast, 2020-2024: Investment Expands Despite the Ongoing Pandemic* (IDC #US46646020, July 2020) and *Worldwide External Enterprise Storage Systems Infrastructure for Workloads Forecast, 2020-2024* (IDC #US46504620, August 2020).

Source: IDC, 2020

Enterprises cite agility, competitive advantage, and lower TCO as key drivers for application modernization. Popular methods to modernize applications include containerization, re-factoring, and re-architecting applications as follows:

- Containerization refers to packaging applications into one or more containers. Because containerization decouples the application from the operating system, it also reduces application dependencies on the OS and minimizes the need for forced upgrades. With the support of stateful data sets by container orchestration platforms such as Kubernetes, database workloads can also be run on containers, obviating the need for large servers or virtual instances.
- Re-factoring involves making internal changes in the underlying components to better take advantage of services available in the cloud. Examples include adopting a database as a service, a broader platform as a service (PaaS), and native cloud-based management tools. Here, the migration integrates the higher-level services offered by the cloud service provider, such as database as a service or serverless functions, toward specific components of the legacy applications.
- Re-architecting refers to rewriting legacy applications to more efficient application architectures. The application continues to deliver the same business functionality. However, it is now architected to operate under a cloud-native framework (i.e., migrating to containerized/serverless architectures). Changes to the architecture are external to the cloud service itself but internal to the application. These changes may result in the application leveraging specific cloud-native services on the public cloud.

With the adoption of modern architectural paradigms, enterprises are also adopting modern application life-cycle management practices. The adoption of DevOps processes, such as CI/CD, is increasing. An IDC survey (see *Application Services, 2019*, IDC #US45005516, April 2019) of enterprises shows that nearly 75% of the respondents rated application modernization as a high or top priority. Another IDC survey (see *U.S. DevOps Survey of Large Enterprise Organizations, 2019*, IDC #US45688619, December 2019) reveals that more than 75% of the respondents have already adopted DevOps practices.

As more enterprises are pursuing application modernization, IDC observes that this is not without challenges. Key challenges include a lack of clarity on what applications to prioritize, a lack of application modernization expertise, and unrealistic TCO expectations. Though enterprise organizations are adopting DevOps practices, most organizations are reporting that less than 20% of their applications are using DevOps methodology. IDC's research on the maturity of DX (see *IDC MaturityScope Benchmark: Future Enterprise in the United States, 2020*, IDC #US45647618, November 2019) shows that only about 21% of the respondents are at mature stages of their journeys.

Acceleration Through Hybrid Cloud Infrastructure

IDC defines a hybrid cloud as using IT services (including IaaS, PaaS, and SaaS) across one or more deployment models and locations using a unified framework. This includes a combination of on-premises traditional IT, private cloud, and public cloud deployment models across multiple deployment locations. Hybrid cloud provides organizations with flexibility and infrastructure to deploy business applications and consistent operational experience across heterogeneous environments.

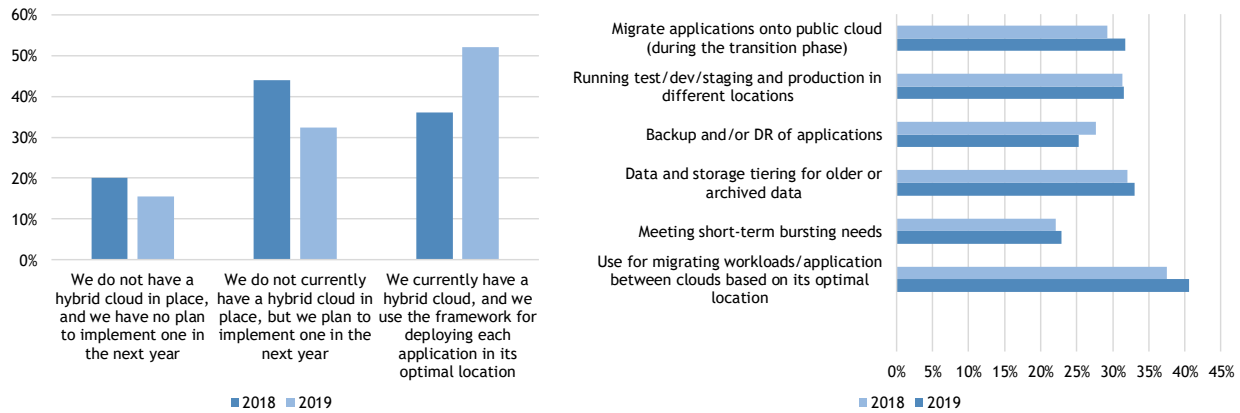
IDC observes that enterprise adoption of hybrid cloud environments is increasing. In a recent survey (see *IaaSView 2019: Worldwide Survey Results*, IDC #US45653819, November 2019), 52% of the respondents indicated actively using hybrid cloud environments (see Figure 3). In the same survey, respondents indicated using hybrid cloud platforms for optimal workload placement, application migration to the public cloud, and data/tiering needs. Respondents also indicated skill set limitations, unclear ROI, and a lack of off-the-shelf products as reasons for not leveraging hybrid cloud infrastructure. These findings are in line with other IDC research, which show lack of skill set, a lack of consistency in tooling, and mismatched expectations on TCO as the primary challenges to adopting hybrid cloud platforms.

FIGURE 3

Hybrid Cloud Is the Way

Q. How would you describe your organization's adoption of hybrid cloud?

Q. What are the top infrastructure use cases for which you use a hybrid cloud environment?



n = 1,129 for 2018 data, n = 1,529 for 2019 data

Source: IDC's *IaaSView Survey*, 2018 and 2019

IDC observes that though more enterprises are prioritizing infrastructure modernization, they are also facing challenges. Enterprises report operational complexity, a lack of expertise, and mismatched expectations as top inhibitors for infrastructure modernization.

Enterprises are also perplexed with the complexity of "day 2" operations across heterogeneous environments. Day 2 operations commonly refer to the maintenance and upkeep of day-to-day operations of the IT infrastructure to ensure continuous availability of infrastructure and applications. Enterprise IT admins have well-established processes and workflows to manage traditional datacenters. They also have full access and control to these environments. In the case of downtimes, they know what needs to be done to troubleshoot and fix the outage.

Public cloud platforms introduce additional complexity into day 2 operations with a different set of tooling, levels of visibility, access, and control. With multiple cloud platforms in the mix, managing these environments becomes even more complicated because of the lack of consistent APIs and tools to manage different cloud platforms. With data gravity and service gravity significantly influencing workload placement in a heterogeneous environment, the need for consistent tooling to manage and operate workloads across these environments is more pressing.

A Foundation for DX

Modern infrastructure paradigms such as virtualization, cloud computing, containerization, serverless infrastructure, and accelerated hardware provide the foundation for digital transformation. Adopting modern infrastructure paradigms enables enterprises to modernize their applications and business processes.

Operating system environments provide necessary system primitives to support these infrastructure paradigms. Without the support of such primitives, applications cannot leverage these infrastructure abstractions. For example, open source virtualization is built into the Linux operating system through the Kernel-Based Virtual Machine (KVM). This enables the Linux operating system kernel to operate as a hypervisor on x86 hardware containing virtualization extensions (Intel VT or AMD-V).

Containers are system processes that provide necessary and sufficient runtime environments to run a single application/service. Containers provide a virtual machine (VM)-like experience without the need for complete operating system installation. Multiple containers can be packed onto a virtual instance or on a bare metal server, thereby providing opportunities for server consolidation. Using containers instead of full virtual machines also saves on operating system licensing costs because the operating system as a whole is no longer needed to run an application. Because containerization decouples the application from the operating system, it also reduces application dependencies on the OS and minimizes the need for forced upgrades.

Deploying containerized applications at scale is not trivial; it involves various aspects such as providing a runtime environment, managing service dependencies, authorization and authentication, isolation, resource provisioning, hardware abstraction, and enabling programming access. A container orchestration platform is needed to provide such necessary primitives. Kubernetes has emerged as the most popular container orchestration platform. Managing containerized applications is also nontrivial, with newer approaches to monitoring, logging, tracing, and troubleshooting required. Open source-based projects have led innovations around this space, with Linux being the most popular choice of operating system to deploy containerized applications.

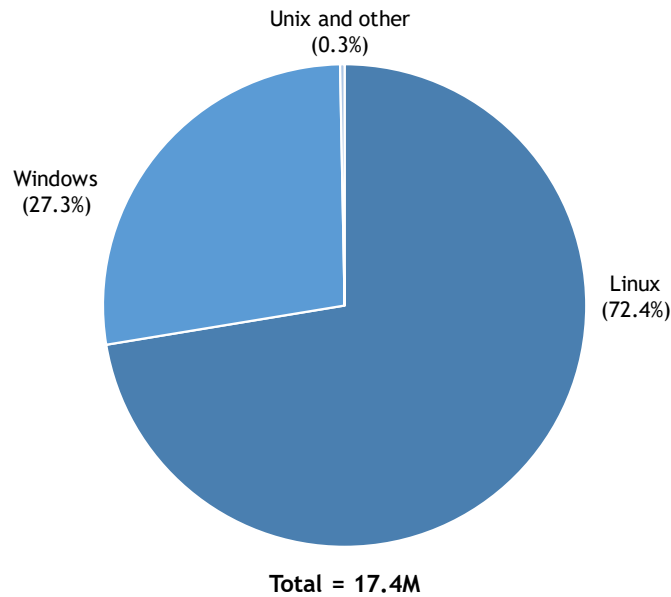
Operating systems also enable leveraging accelerated hardware such as GPUs through necessary hardware abstractions. Through these abstractions, AI/ML applications can leverage the power of GPUs to train or run inference on machine learning models. These abstractions also enable using a combination of heterogeneous hardware, such as x86 and GPUs, side by side.

Growth of Linux-Based Operating Environments

While the Windows Server operating system takes the lion's share of OS revenue, the Linux operating system dominates the install base. Linux is widely adopted among enterprises to power their business applications. Enterprises have started relying more upon commercial Linux distributions than open source distributions, as seen from IDC's operating system environment Market Share studies. In 2019, about 72% of the servers shipped were deployed with variants of the Linux operating system. IDC's research also shows that nonpaid/free Linux distributions have a larger install base than paid/commercial distributions, particularly in public cloud environments (see Figure 4).

FIGURE 4

Worldwide Server Operating Environments Market Shares, 2019



Source: IDC, 2020

Challenges with Open Source Operating Systems

While enterprises are increasingly adopting open source-based products/Linux distributions, they also face challenges using such products/distributions. Security concerns, a lack of unified support, and difficulty in day 2 operations are some of the critical inhibitors cited by enterprises. These enterprises cite security, a one-stop place for all their support needs, flexibility and choice (of application architecture, deployment models, and locations) provided, lower licensing costs, and better tooling to ease day 2 operations as key metrics when selecting an operating system.

Benefits of Commercial Linux OS

A commercial Linux distribution such as Oracle Linux can help mitigate the key challenges cited by enterprises through its key differentiators including:

Security

- Security/enterprise-grade hardened operating system that provides application binary compatibility with other major Linux-based commercial operating systems

Performance

- Performance optimized for database-intensive business applications

Integrated Tooling

- Integrated tooling for efficient day 2 operations

Flexibility and Choice

- Provides choice and flexibility of virtualization platforms (open source KVM and oVirt-based virtualization manager)
- Supports multiple cloud platforms including Oracle Cloud Infrastructure (OCI), AWS, and Azure

Support for Heterogeneous Applications

- Enables cloud-native application development through support for popular container runtimes and container orchestration platform (Kubernetes)

One-Stop Shop Support Needs

- Everything included in a single support offering: OS, virtualization, management, clustering, and cloud-native tools — simplifies operations, reduces cost, and makes managing budgets easy
- World-class support for business applications running on premises or on public cloud environments

HOW ORACLE LINUX ENABLES DIGITAL TRANSFORMATION

The operating system plays a foundational but invisible role in enabling digital transformation. Oracle Linux – through its features, tools, and capabilities – can provide such a reliable foundation. More specifically, Oracle Linux can enable enterprises in digital transformation through the capabilities discussed in the sections that follow.

Provides Foundational Support for Enterprise Applications

Enterprise business applications have demanding performance and high availability requirements. Any loss of business continuity translates directly into a loss of business revenue. Any performance degradation affects customer experience and satisfaction and possible loss of transactions.

Oracle Linux is fine-tuned for high-performance requirements of database applications deployed on both bare metal servers and virtual machines. Oracle Linux has also gained mindshare among enterprise organizations as the most sought-after operating environment for data management applications and business applications.

Enterprise IT environments and business applications are getting more virtualized. Oracle Linux supports multiple virtualization platforms, including KVM and Oracle Linux VM Manager, providing flexibility and choice of virtualization platforms. Oracle Linux KVM supports other Linux distributions, including RHEL, CentOS, Ubuntu, and SUSE Linux, as well as Microsoft Windows as the guest OS. Oracle Linux Virtualization Manager, based on the open source oVirt project, allows enterprises to continue supporting existing KVM deployments on premises. As Oracle Cloud Infrastructure also uses the same hypervisor, Oracle Linux KVM enables an easy migration path for workloads to OCI.

Enables Application Modernization

More enterprises are adopting cloud-native applications and architectures for their business needs. Support for building, deploying, and managing cloud-native applications is not trivial. It involves enabling container runtimes, managing container images, orchestrating containers, supporting networking and storage abstractions, and providing ways to monitor/observe containerized applications.

Oracle Linux enables enterprises to build, deploy, and manage cloud-native applications along with virtualized applications through its support for the entire cloud-native stack. Oracle Linux also enables deploying cloud-native applications on both bare metal servers and virtual machines.

Oracle Linux includes container tools that enable developers to build, test, and run containers as part of their workflow. On Oracle Linux 7, this is provided by Oracle Container Runtime for Docker, which Oracle builds using the Moby Project source code, which is the same upstream project used to build Docker CE. Oracle Linux 8 introduces the Podman suite, which includes Skopeo and Buildah. The Podman suite is also available as a tech preview for Oracle Linux 7. Oracle Linux Cloud Native Environment supports popular container runtimes, including runC and Kata Containers through CRI-O. While runC is the most popular container runtime deployed, Kata Containers provide better isolation through the use of lightweight VMs on top of the KVM hypervisor. Isolation is provided by specific hardware support including Intel VT-x and VT-d extensions and AMD SEV. Kata Containers are well suited for running on bare metal servers but are also supported on cloud-based virtual instances that support nested virtualization like Oracle Cloud. Prebuilt container images and packages for popular tools and platforms such as Oracle Database, MySQL, and Java are available at the Oracle Container Registry, which makes building and deploying containerized applications easier.

Oracle Linux provides an open source Certified Kubernetes distribution along with necessary plug-ins (CNI for networking and CSI for storage) and associated projects (such as Prometheus for monitoring and Fluentd for logging). Through support for the CNI plug-in, cloud-native networking capabilities can be enabled through open source projects such as Calico and Flannel. Similarly, storage needs for stateful applications can be enabled through the CSI plug-in using open source file systems such as GlusterFS.

Oracle Linux also enables running microservices-based applications through its support for Service Mesh Interface (SMI)-compliant service mesh platforms, including Istio. Finally, Oracle Linux provides the necessary capabilities to modernize Oracle Fusion Applications into cloud-native applications.

Makes Day 2 Operations Easier

Oracle Linux provides the following tools and capabilities to ease day 2 operations and provides consistent management of heterogeneous environments:

- **Ksplice** enables updating select, critical components on Oracle Linux deployment with all critical security patches without rebooting. Rebootless updates save time and pain, avoid downtime, and proactively prevent security incidents.
- **DTrace** is an advanced tracing tool to enable troubleshooting in real time. DTrace provides operational insights such as memory consumption, CPU utilization, and calls tacks.
- **Oracle Autonomous Linux** enables automatic patch updates and performance tuning without manual intervention. Oracle Autonomous Linux is available on Oracle Cloud for customers and includes Oracle Linux Premier Support. Because it is based on Oracle Linux, Oracle Autonomous Linux allows customers to run other Linux (especially RHEL) workloads without modification on OCI to leverage this capability.

Apart from providing powerful tools and capabilities to ease day 2 operations, Oracle also provides a one-stop shop for world-class support for the entire stack, from the virtualization layer to the application layer. Oracle Support is available in multiple tiers, appropriately priced to provide better value. Through application binary-level compatibility, Oracle can extend its support capabilities for applications running on other Linux distributions such as RHEL. Subscribing to Oracle support is also less restrictive than competitors, with support costs paid only for the servers and instances when and where the support is enabled.

Optimizes Support Costs

Through its Premier Support offering that includes 24 x 7 support for unlimited virtual machines, Oracle reduces support costs on Oracle Linux VMs. Oracle Linux images are free to download and distribute without any licensing costs. Support costs are charged only after the support is enabled.

Oracle Linux also enables cost optimizations through licensing advantages with Oracle Linux Virtualization Manager. KVM CPU pinning allows VM threads to be assigned to specific CPU cores, thereby consolidating the number of cores utilized. This, in turn, minimizes licensing costs for operating systems such as RHEL, which are licensed based on the socket-pair basis.

Supports Open Multicloud

Oracle Linux is supported on multiple cloud platforms, including OCI, AWS, and Azure. Oracle is the only vendor that offers the same Linux distribution it runs its cloud infrastructure on, to their customers to run both on premises or in the cloud. Through application binary compatibility with RHEL, Oracle Linux enables an easy migration from other Linux distributions. With this combination of binary compatibility and multicloud platform support, Oracle Linux offers a solid choice for customers requiring hybrid multicloud support.

Enterprise customers running business applications on Oracle Linux on premises have an easy and direct path to migrating to Oracle Cloud. Customers can leverage capabilities, such as Oracle Autonomous Linux available on OCI, and more automation, such as autoscaling, life-cycle management across pools, and monitoring. Customers can also migrate to other public cloud service platforms such as AWS or Azure as Oracle Linux is natively supported on these platforms.

Enterprise customers running applications on other Linux distributions such as RHEL can also migrate their applications as-is to Oracle Linux on premises or on public cloud platforms, including OCI, to leverage the advantages provided by Oracle Linux.

FUTURE OUTLOOK

Hybrid Cloud – The New Normal

Hybrid environments are fast becoming the new normal of enterprise IT infrastructure. IDC expects this trend to continue, with enterprises leveraging diverse infrastructure abstractions across multiple locations through multiple deployment models. Enterprises need to be able to manage different server types, CPUs, and storage back ends. They need to ensure the availability of applications running on bare metal servers, virtual machines, containers, and other infrastructure abstractions. Security boundaries are now extended past the datacenter, extending to public cloud and edge locations. With such variety in heterogeneous environments, IT admins need a unified platform that enables a simple, secure, consistent experience to ease management and operations. The underlying operating system needs to provide the foundation for such consistent operational experience. Oracle Linux, through unique capabilities such as Autonomous Linux, is well positioned to provide such foundation for consistent operational experience across hybrid cloud environments.

The Growth of Cloud-Native Applications

More enterprises are adopting the right infrastructure abstraction for the right workload paradigm. For example, enterprises leverage containers and cloud-native technologies for applications that need massive scale and are less stateful. They are also embracing AI/ML technologies for new business use cases deployed across cloud, core, and edge locations. A recent IDC study predicts that by 2024, 55% of the enterprises will rely on embedded AI functions in their business-critical workloads to make real-time business decisions and drive business process outcomes directly.

Enterprises are increasingly adopting cloud-native architectures for their business workloads. IDC estimates that by 2024, more than 30% of infrastructure spend on enterprise workloads is expected to power cloud-native applications.

With such growth in cloud-native applications and many infrastructure abstractions, it is more important than ever for the underlying operating system to support heterogeneous workloads. Oracle Linux is well positioned to be the foundation upon which enterprises can leverage heterogeneous workloads.

CHALLENGES/OPPORTUNITIES

Opportunities

Enabling Support for Heterogeneous Workloads

Historically, Oracle and Oracle Linux have been strongly associated with database workloads. With optimizations for database workloads, enterprises have been primarily leveraging Oracle Linux for their database needs on bare metal environments.

However, Oracle Linux is not just about databases. With the support for KVM and oVirt-based virtualization, cloud-native technologies including Docker and Kubernetes, integrated tools for day 2 operations, and kernel-based support for multiple Linux distributions, Oracle Linux is well positioned to support heterogeneous workloads. Furthermore, capabilities such as support for SMI-compliant service mesh platforms such as Istio render Oracle Linux ready for microservices-based applications. Oracle Cloud Infrastructure also enables leveraging GPUs for AI/ML workloads through NVIDIA GPU Cloud (NGC) on OCI or bare metal GPU.

Enterprises are increasingly running heterogeneous applications and are using hybrid cloud platforms to deploy these applications. An open operating system that supports multiple infrastructure abstractions provides compatibility with different operating system kernels and enables interoperability between on-premises and public cloud environments to prove to be an ideal platform to support heterogeneous workloads across hybrid cloud infrastructure. Oracle Linux fits the bill.

Challenges

Mindshare

Enterprises look to Oracle for their business-critical/mission-critical database needs. Enterprises adopt Oracle databases because of their performance, availability, and the support capabilities provided by Oracle. Oracle customers are also taking advantage of Oracle's SaaS offerings to migrate their business-critical workloads to the cloud. However, many are not aware of Oracle's open source contributions.

Oracle has been a strong supporter of open source through participation, sponsorship, and leadership. Oracle is a founding member of key open source foundations, including the Linux Foundation, Eclipse

Foundation, and the Java Community Process. Oracle is also a key sponsor of open source organizations that have been accelerating innovations around cloud-native technologies, including the Cloud Native Computing Foundation. Oracle is the home for Java and MySQL, the leading open source language and database, respectively.

With such support for open source technologies across the stack — including virtualization, operating system, containers, middleware, language, and database – Oracle is uniquely positioned to enable digital transformation based on open source technologies.

ESSENTIAL GUIDANCE FOR CUSTOMERS

Consider Open/Flexible Operating Systems

IDC recommends enterprise organizations to consider an open operating system that provides more flexibility and choice.

Enterprise IT organizations are increasingly leveraging heterogeneous workloads running on bare metal servers, virtual machines, or containers. Hybrid environments consisting of on-premises and public cloud infrastructure are also fast becoming a reality for enterprise IT organizations. An open and flexible operating system enables enterprises to support heterogeneous workloads and place them strategically across on-premises or public cloud environments. This flexibility and choice in infrastructure enable developer agility, which in turn provides enterprises with competitive advantage.

Open, flexible operating systems also enable enterprises to port workloads running on the different operating systems to a single platform, thereby providing maximum flexibility. Such a consolidation of operating environments also provides an opportunity to optimize licensing costs on operating systems, thereby providing better TCO. IDC recommends selecting an open operating system such as Oracle Linux that provides flexibility and choice to support heterogeneous workloads across on-premises and public cloud environments.

Future-Proof Investments: Optimize for Now, Plan for Future

Enterprises are often caught in the dilemma of supporting legacy investments while planning for future innovations. An operating system that can support both legacy and modern workloads helps enterprises overcome this dilemma. IDC recommends that enterprises optimize for now by consolidating legacy workloads to an open and flexible platform so that they are well positioned to capitalize on future innovations.

Think More than Databases

Enterprises also tend to focus on requirements posed by the workloads currently in use, such as databases or productivity workloads. In doing so, they tend to prioritize immediate technology drivers and business drivers while selecting an operating system. Technology drivers include support for diverse hardware, flexible open source ecosystem, and improved day 2 operations. Business drivers include lower TCO, lower support costs, and support capabilities.

IDC recommends that enterprises look further than their current needs and consider the types of workloads they may be using in the future. With more enterprises adopting heterogeneous workloads across heterogeneous platforms, it is critical that the vendor understands the nuances of supporting business-critical workloads across such environments. IDC recommends selecting a vendor that has demonstrated deeper understanding of supporting business-critical workloads across such diverse environments.

CONCLUSION

Operating systems provide the foundation for digital transformation. Oracle with its Oracle Linux OS offers an optimized foundation through its security, performance, flexibility, and choice; integrated tooling for better day 2 operations; support for heterogeneous applications; and a one-stop shop for support.

IDC recommends that enterprises consider a commercial Linux operating system to overcome commonly faced challenges with open source operating systems. IDC also recommends selecting an operating system that supports flexibility, choice, and better tooling and that is backed by a vendor that can provide world-class support for the entire stack.

About IDC

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