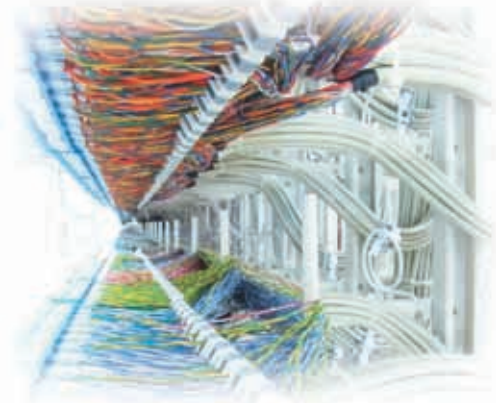


# The OS Faces a Brave New World

➔ David Geer



**Increasingly popular approaches such as virtualization, cloud computing, and application-development frameworks are changing the importance of the traditional operating system.**

**T**he operating system has always been the heart and soul of servers and personal computers. It manages activities such as computer-resource sharing, application hosting, hardware operation, and hardware-software interfacing.

The OS controls and initiates application execution and provides services such as I/O operations, a file system, and communications among processes.

In addition, the OS provides abstractions of the underlying hardware, which can help developers write applications that will run on the operating system.

The OS has been so critical to computer operations that Microsoft became the world's largest software vendor largely by controlling the PC operating-system market.

However, three major software-related developments are decreasing software's reliance on specific, full-featured server and PC operating systems.

Virtualization lets a single server host slices of multiple operating systems—each of which can run different applications—within virtual machines. This makes the installation of any single full-featured OS instance a choice rather than a necessity.

Cloud computing features applications that run on servers spread across the Internet. Cloud providers push these applications to users' browsers. Users of cloud-based software thus don't need an OS to do more than run the browser.

Developers are increasingly using frameworks that enable the faster building of applications that work with multiple OSs, again making the use of a specific operating system less important.

The Just enough Operating System (JeOS, pronounced "juice") movement focuses on packaging an application with only the parts of an OS necessary for it to work.

Over time, these developments could affect what constitutes an operating system, what its roles and responsibilities will be, and how it will be installed and used, said University of Michigan professor Peter M. Chen.

## OS BACKGROUNDER

Early operating systems on 1950s mainframes included the tape-based IBSYS and the Fortran Monitor System (FMS), said Vrije Universiteit professor Andrew Tanenbaum.

The first PC OS was MS-DOS, which Microsoft released in 1982. Apple released the first MacOS in 1984.

Traditional operating systems allo-

cate and share memory, disk space, peripherals, and other resources among multiple applications and users, according to Tanenbaum. Applications use predefined system calls to access OS services, he said.

OSs manage hardware via the kernel. For example, the kernel controls disk reads and writes, as well as memory and I/O-device access.

Operating systems interface between hardware and software by providing applications with simpler, more abstract versions of the underlying hardware to interact with, such as files that represent hard disk space.

Application developers write programs to work with the abstract representations that the OS provides.

Traditionally, applications have run directly on PCs or servers. Each PC or server would run just one operating system. And a vendor had to rewrite its applications for each OS they would run on.

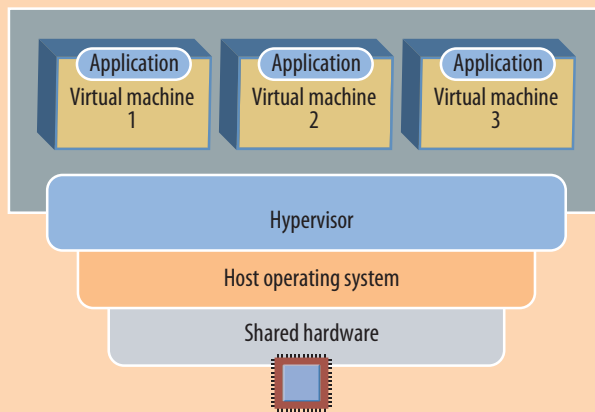
These factors made the choice and use of an OS important.

## THREE NEW APPROACHES

Three technologies could change the OS and its importance.

### Virtualization

Virtualization is the most profound change that PCs and servers have



**Figure 1.** Virtualization systems install a hypervisor on top of the host computer system's OS. The hypervisor runs virtual machines, which are emulated hardware devices. Each VM can run a different OS. Users thus don't have to choose one OS to work with and don't have to base their choice of applications on a single OS. Also, the hypervisor handles tasks for which the OS has traditionally been responsible.

experienced, said Simon Crosby, chief technology officer for Citrix Systems' Data Center and Cloud Division.

"IT departments have long been at the mercy of the technical demands of legacy applications," explained Chris Van Dyke, Microsoft's chief technology strategist for the oil and gas industry. "Now, rather than having to maintain older operating systems because of the needs of a legacy application, IT departments can take advantage of the performance and security gains in a new OS [in one virtual machine] while supporting legacy applications in another. Also, the process of deploying applications becomes simpler, because applications can be virtualized and deployed as a single virtual machine."

**How it works.** Virtualization technology lets a single PC or server simultaneously run multiple operating systems or multiple sessions of a single OS. This lets users put numerous applications—even those that run on different operating systems—on a single PC or server instead of having to host them on separate machines as in the past.

The approach is thus becoming a common way for businesses and individuals to optimize their hardware

usage by maximizing the number and kinds of jobs a single CPU can handle.

In a virtualization system, as Figure 1 shows, the hypervisor—also called a virtual machine monitor—allocates the host machine's resources to each virtualized operating system or to each program running on a virtualized OS, said Crosby.

The hypervisor, which can be installed on its own or as part of an OS, emulates a hardware device—also called a virtual machine (VM)—for each virtual operating system, explained Parallels CEO Serguei Belousov.

The hypervisor also handles each operating system's communications with the CPU, the storage medium, and the network, he added.

To execute programs, the hypervisor hands off CPU control to a virtual OS on a VM, said Crosby.

Most VMs use virtualized network connections to communicate with one another.

**Vendors and products.** Major virtualization vendors and products include Amazon's Machine Image, Citrix's XenApp and XenServer, Microsoft's Hyper-V, the Oracle VM, Parallels' Virtual Appliance, and VMware's vCenter Server.

**Effects on the OS.** With virtualization, users no longer have to choose one operating system to work with and don't have to base their choice of applications on a single OS.

According to the University of Michigan's Chen, this enables the use of many operating systems on a single machine, loosening the hold that any one OS has on them.

In addition, the hypervisor handles several of the important tasks for which the OS has traditionally been responsible, reducing the operating system's importance to users.

## Cloud computing

Cloud computing lets users access programs, storage, processing, and even application-development platforms—hosted by service providers on virtualized or distributed systems—over the Internet via a browser. The providers either offer the applications themselves or host the user's software.

Proponents say the technology yields cost savings, high availability, and easy scalability.

**How it works.** Cloud-computing providers' infrastructures consist of Internet-connected servers, at one site or distributed across several locations, that house applications and data. They also include grid, management, database, and other types of software; user interfaces; APIs; and a communications infrastructure for connecting to users over the Internet or a private network.

Some service providers use virtualization to efficiently run services for multiple customers on a single computer, rather than putting each client's services on a different machine.

**Vendors and products.** Major offerings and vendors include Amazon's Elastic Compute Cloud, AppNexus' Cloud platform, Google's App Engine, Microsoft's Windows Azure platform, Salesforce.com's Force.com platform, ServePath's GoGrid platform, and VMware's vSphere cloud OS.

Google says its soon-to-be-released free Chrome OS will have just enough functionality to let users operate their Chrome browsers and access cloud-based applications and data via the Internet.

**Effects on the OS.** Users of cloud-based software access applications via a browser. They thus don't need an OS to do more than run the browser.

Cloud systems share memory, disk space, peripherals and other resources among multiple applications and users by providing each with isolated access to the network, storage, and server virtualization layers. The systems use a hypervisor to isolate allocated hardware resources to run workloads.

They manage hardware-software interfacing via APIs, as well as connection and messaging protocols such as TCP, HTTP, and SOAP, according to Salesforce.com director of platform research Peter Coffee.

### Development frameworks

Many application developers are writing to frameworks, said Tom Bitman, vice president of virtualization and cloud computing for market-research firm Gartner Inc.

Application development frameworks (ADFs) enable developers to write programs using runtime environments, as well as common object-oriented libraries of interfaces, translation code, and runtime logic.

The code in the runtime environments maps the functions provided by the ADF to the services and resources provided by each supported OS, according to Dennis Moreau, senior technologist for EMC Corp., an information-infrastructure-technology vendor.

The libraries and runtime logic have been abstracted so that developers can use them to write applications once. The ADF then translates the applications so that they can work with different operating systems.

**Vendors and products.** ADF platforms include the open source

Django and Ruby on Rails, as well as Microsoft's Silverlight, all for Web applications; and Oracle's Application Development Framework for enterprise programs.

**Effects on the OS.** Many developers now write applications that rely more on frameworks and less on OS services. Development frameworks contain all the logic required to translate between standard ADF calls and the resources the application needs from any of numerous operating systems.

Because this also enables the building of applications that work with multiple OSs, the use of a specific operating system is less important.

### Just Enough Operating System

In contrast to the traditional operating system, a JeOS offers only the components necessary to make an application run—without unnecessary interfaces, functions, libraries, and services.

It is packaged with the software to form a prebuilt, preconfigured, ready-to-run application appliance within a virtual machine.

The JeOS is a lightweight, low-memory-footprint, easy-to-install system including only the code necessary to boot and support a file system, storage devices, and networking and to manage the package, explained Boris Devouge, sales engineer with Canonical, the commercial sponsor of the Ubuntu Linux-based OS, which has a JeOS version.

Other JeOS platforms include Novell's SUSE Linux Enterprise JeOS, Oracle's Enterprise Linux JeOS, and Sun's OpenSolaris JeOS.

"A JeOS will deal with I/O, file systems, application notification, and error detection exactly the same way as a full-blown operating system by using the routines and subprograms included in the kernel and its core libraries," said Devouge.

Virtualization technologies elsewhere on the server perform much of

the other work—such as interacting with hardware like network interface cards, storage media, and CPUs—that an OS typically handles. This allows the JeOS to be much smaller, said EMC's Moreau.

According to Devouge, a JeOS lets organizations have an agile and minimal OS install while worrying less about software dependencies, testing, updating, and maintenance.

**O**pinions differ on the impact that new developments will have on the OS.

Said Vrije Universiteit's Tanenbaum, "Cloud computing's main effect is that applications will run on remote servers so that you don't need to run so much on the local machine. Whether this will entirely replace running programs locally remains to be seen."

According to Salesforce.com's Coffee, "The function of the OS, increasingly, is to get out of the way—as indicated by the surge of commercial revenues from lightweight netbook machines and by the buzz surrounding Google's Chrome OS."

Regardless of cloud computing or virtualization, said the University of Michigan's Chen, there will still be hardware and software, and this will require an OS between them to abstract and simplify matters. **■**

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