

Linux in healthcare is a tale of things seen and unseen. Linux/Open Source have enjoyed tremendous popularity in embedded systems and networks for major technologies used in healthcare that healthcare providers may not even be aware of. It has also experienced a steady adoption rate in healthcare applications. Nevertheless, the adoption rate of Linux/Open Source in healthcare lags that of other industries. Here's why, and how that could change.

In 2006, Linux server sales are outpacing overall server sales by an 8:1 ratio, and Linux is outpacing Windows as an operating system in new sales at a rate of 5:1. This growth is occurring across all industry sectors, including healthcare, but healthcare presents a unique challenge. The criticality of patient care, coupled with intense regulation and limited IT budgets, delays adoptions of new technologies in healthcare.

"Many healthcare organizations have been using the same technologies for 20 or 30 years," said Chris Bidleman, Director of Healthcare Solutions for the Americas for Novell. "In our healthcare trade show booth year after year, we had about the same volume of visitors. But after the healthcare information management initiatives (HIMS) last year, we noticed a significant increase in conversations around our trade booth at healthcare shows about Linux and Open Source. In fact, there was probably more volume in visitors and organizations at our healthcare trade booth last year than in all the previous years combined."

Bidleman says that Novell has seen many hospitals asking about the Linux desktop, which has begun to open some eyes because it can save \$50-\$300 per desktop in licensing and management expenses. Nurses and other healthcare administrative staff who don't typically use Microsoft's *Office* products can just as easily work on Linux desktops, where navigation and other functions are straightforward, and learning curves are easy to manage.

"Overall, there is a large market opportunity for Linux in hospitals — but we see everyone moving toward information sharing and interoperability, which Linux/Open Source offers," said Tom Wunderlich, Red Hat's Product Management Director for Vertical Markets.

Red Hat, Novell, IBM and others acknowledge a lot of interest in Linux servers from the middle tier market of healthcare providers, who do not have the history of mainframe investments that large healthcare organizations have. "What's unique about healthcare in 2006 is that, for the first time, small- and medium-sized organizations will spend more in cumulative dollars than

large-scale organizations on IT,” said Scott Handy, Vice President of Worldwide Linux and Open Source, IBM-wide Infrastructure Initiative, IBM Systems and Technology Group. “Overall, the U.S. spends 1.7 trillion dollars on healthcare annually, so even a small percentage of revenue allocation to IT is a big number.”

Mature Linux platforms offer better performance, lower cost, and superior openness than *Unix*, a traditional mainstay in many smaller office and research laboratories. The importance of commercial Linux is also central to healthcare organizations. Nevertheless, there is still a lingering perception that Linux is for hobbyists and not for mission-critical applications.

### The Chicken and the Egg

Commercial Linux is central to most healthcare buying decisions because healthcare providers want the assurance and the backing of strong vendors that will stand behind hardware and applications. They also want packaged applications that will fill the niches that they need to fill.

Here is the dilemma: There are still relatively few clinical systems and databases based on Linux and Open Source environments. Traditional healthcare software providers have proprietary solutions that they are slow to convert to a Linux platform — and the only thing that can change this is direct market pressure from the healthcare providers themselves.

Lille Corporation, a New York-based Novell reseller, decided to take an aggressive approach to Linux/Open Source. “In the early 1990s, we asked ourselves how we could deliver medical software to physicians throughout the U.S., and we began to look at different tools that we could use to produce the software,” said Jordan Rosen, Lille’s President. “We performed a comprehensive analysis of all of the tools and commercial libraries that could be used in software development, and we found a huge body of resources in Open Source. We also discovered that application prototyping with Open Source was superior to prototyping capabilities in other toolsets we had analyzed. Open Source applications offered outstanding functionality, and there was also the ability to get rapid support with such a well-established worldwide community of software developers.”

Rosen explained the value to product developers of tools that give you source code that you can modify and compile into your own products. “This made a tremendous difference to us in

our speed to market,” said Rosen. “We found we could develop software and deliver it for use in our software as a service sales model. In doing this, we were able to provide our healthcare customers with a low-cost, managed, and secure solution. It was this turning point that convinced us to develop with Linux exclusively.”

Lille’s story is not unusual. Many commercial developers of medical software on the Windows platform actively use Open Source for underlying capabilities like security, compression, and Web services, and because Open Source works on so many different computing platforms. These vendors recognize the value of Open Source as a way to leverage and get products to market without reinventing the wheel. Better yet, the use of Open Source is entirely transparent to customers using Windows as their desktop operating system.

Rosen notes that the original *MUMPS* (now known as “M”) operating system first developed at Massachusetts General Hospital was used to write virtually every type of medical application for the VA hospitals. M is public domain software that can be taken by any vendor and adapted for commercial use and sale. Many healthcare software companies that are looking at Linux/Open Source versions of their products are building products around the framework and the code repository already offered by M, to keep costs down and speed time to market. At the same time, these software companies are hearing more from their healthcare customers about the new applications that they would like to see that can interoperate with both Linux and Windows.

### Drivers of Linux/Open Source Adoption

Analysts and industry practitioners have differing opinions of the drivers that are now behind healthcare’s migration into Linux and Open Source, but there are seven major drivers that most agree on:

- **Cost Savings and Reductions.** Linux and Open Source saves money: commodity servers outfitted with Linux are cheaper than specialized or proprietary hardware. Open Source reduces licensing fees. And the perception is that Linux and Open Source lower IT administrative costs.

“The biggest driver for healthcare organizations is reduced costs,” said Bidleman. “More money per capita is spent on healthcare in the United States than in any other country. At the same time, U.S. healthcare has one of the lowest IT expenditure rates, at about 2-5 percent of revenues. Compare this to healthcare organizations in other countries that have an IT expenditure rate that is 5-10 percent of revenues.”

Linux and Open Source also promises to ease system integration. Without much integration, current hospital applications introduce tremendous waste and cost on a daily basis. For example, if a patient switches hospitals, the institutions often have to fax documents back and forth and re-key data. Integration drives these costs down since data is only entered once, and then routed to wherever it is needed.

- **Better Patient Service.** Today's healthcare environment is extremely competitive, and hospitals, clinics, and other institutions are enhancing patient service to differentiate. "Patient service is a very competitive factor for healthcare organizations," said IBM's Scott Handy. "When the patient doesn't have to re-supply information, x-rays, and so on, there is less frustration. Integrated information systems can deliver this."

There is an even more important reason for systems to integrate. In the U.S., it is estimated that 150,000 deaths occur each year because of avoidable medical errors. An electronic patient record and other system integration can preclude many such accidents.

- **Improved Information Sharing.** HIMS and other healthcare initiatives, along with the mandate for an electronic medical record by 2014, are driving healthcare organizations of all sizes to do whatever they can to enhance information sharing. As part of the effort, they are exerting pressures on their hardware and software providers to help.

"The key is adopting standards in these areas: shipments of documents, scanning of documents, content such as x-rays and scans, and data queries," said Scott Handy. "If we can get a full-blown adoption of this by vendors, large, small and medium sized healthcare organizations will all have the support levels from their vendors that they need and we can provide an "on ramp" with affordable solutions for virtually any organization."

- **Satisfactory Vendor Support and the Right Solutions.** Healthcare providers want to see credible vendors with strong applications and support organizations backing Linux/Open Source. This is the "chicken and the egg" dilemma described earlier, because while vendors wait for customers to justify Linux/Open Source ports or investments, customers wait for deliverables.

- **Vendor Independence.** Fenced in by proprietary vendors and forced to pay the high costs of technology licenses and support, healthcare organizations see Linux and Open Source as a way to assert independence. "Even if organizations are using a major brand of Linux, they know that they can easily move to other Linux distributions," said Michael Goulde, healthcare analyst for Forrester, Inc.

- **Adoption by Large Healthcare Providers.** Goulde also believes that many healthcare organizations are smaller clinics that look for dollar savings but also proven applications. "The Linux market is moving slower because many of these organizations or companies are reluctant to move forward until the market does," said Goulde. "They want to see larger organizations making investments in Linux and Open Source, and they want to see vendors more aggressive in providing Linux and Open Source applications."

- **Requirements of the Global Healthcare Environment.** A key driver for hardware and software vendors is the global environment. China is an enormous market opportunity for these companies, but they have to be able to offer Linux solutions to compete there. Europe is also largely Linux-based.

In addition, people (and patients) today are highly mobile. Insurers and healthcare organizations want to know that there are options for healthcare outside of the U.S. "Behind the scene" medical processes also cross national lines. For instance, a doctor or a radiologist can read an x-ray and dictate an analysis which is then transcribed at home by a transcriber on a PC, or in China or India.

### Leading Applications

The leading applications in healthcare that are based on Linux and Open Source are those that are typically hidden from view from all but IT. The applications are embedded systems in medical equipment like CT scanners and network applications, and in Web and print servers and DNS and proxy servers.

"The GE 64-slice CT scanner is the latest technology for imaging using CT," said Jordan Rosen. "It can synchronize x-rays with your heartbeat and take detailed pictures between beats for clarity. These images are capturing so much detail that it's getting to the point where you can see inside coronary vessels without using invasive procedures like catheterization. With this software, it is even possible to do 3D reconstruction of the heart. The entire software suite for this product is based on Linux and Open Source. All of the workstation viewers are Linux."

The push for healthcare information sharing and an electronic medical record by 2014 also has organizations looking at Linux/Open Source, with its promise of standard interfaces that applications can easily integrate with.

"Linux and Open Source have great opportunities in the area of information sharing," said Scott Handy. "Under President Bush, the electronic medical record (EMR) is being mandated to be a widespread reality by the year 2014. To this end, an Integrated Healthcare Infrastructure (IHI) standard has been defined. Here at IBM, we have built the first implementation of it, and we anticipate strong adoption by large healthcare organizations. If you are a small or medium sized healthcare organization, you need to partner with someone that can get you to the same set of standards.

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We believe that we can deliver a more open version of IHI by using Open Source and Linux technology that is standards-based and scalable to the cost structure of smaller organizations. In this way, the entire healthcare information exchange can be facilitated.”

Handy explains that to attain a universal EMR, every vendor has to support the same set of interfaces. In 2005, IBM embarked on a mission to rewrite its proprietary interfaces to an Open Standards protocol, using Eclipse as a foundation. It implemented HIT as a research project, got hospitals to connect to it, and convinced business partners to adopt it.

“The options for vendors are to not use standards and to write the interfaces for the EMR themselves, which is expensive—or to use Open Source standards,” said Handy. “To the degree that everyone adopts the Open Source standards and uses the same code, we will have heightened interoperability and integration.”

Slower to move and yet still moving forward, are administrative and office applications that use Linux/Open Source. Since many healthcare personnel have extensive skills in Office applications, and since Linux/Open Source presently has weaknesses in areas like spreadsheet software, the main activity for Linux/Open Source on administrative applications has been in areas like portable kiosk stations for nurses and/or other administrative applications that do not require Microsoft Office.

“There are opportunities for sales on the server side, but the desktop area has been much slower to move into,” said Ce Ce Bowman, Industry Marketing Manager for Healthcare, Novell. “In general, IT is not receptive to having to manage two different operating system environments (Linux and Windows, or Linux and UNIX). ”

Jordan Rosen of Lille Corporation reported one mobile communications package for ambulances that Lille created that has been very successful. “Ambulances need effective mobile communications from their laptops, and we found that it was possible to develop a low cost Linux-Open Source solution by using elements of amateur radio technology and combining them with robust security, high reliability, low cost and scalability,” said Rosen. “This solved the problems of our customers, who were frustrated with antiquated systems and questionable systems stability—and who at the same time had to posture themselves for rapid growth.

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“The architecture we sell is a thin-client Linux deployment that runs Citrix servers under Linux and provides end users with 80 percent of their needs through Linux-based software like *Mozilla* and Firefox.

The clients can run native Linux applications, but they can also run Windows applications if that is what the user needs. It can scale from five to 10,000 desktops. With this kind of flexibility and the ability to use both Linux and Windows, organizations are well-positioned to respond to any business need with their software of choice.”

### Barriers to entry

Linux/Open Source is moving forward, but there are still major “barriers to entry” in healthcare that must be overcome. These include concerns about security, constraints on change in IT, and a general lack of understanding about Linux/Open Source.

There are some perceptions that Linux is not secure. In reality, it is a more secure operating system than Windows. With Linux/Open Source, everyone can see the code before it is compiled, and verify that there are no “back doors.” Open Source can also incorporate data encryption, access, biometrics, and other special forms of security. Both Linux and Unix have an EAL+ 4 security rating.

Healthcare IT is also subject to system “change constraints” for reasons of cost, replacement pains and general inertia. “Like all technology transformations, there is always a group that says, ‘If it ain’t broke, don’t fix it,’” said Scott Handy. A complement to this problem is the dearth of vendor-supplied clinical applications using Linux.

“We keep an eye on the ecosystem of healthcare system integrators and technology suppliers,” said Red Hat’s Tom Wunderlich. “We ask ourselves, ‘How can we be sure that they are integrated into Linux hardware and Open Source software?’ We certify partners in both the hardware and software areas. The goal is that all systems that run on Windows or Unix can run in Linux also. When the end customers are demanding high performance, low cost solutions, it is incumbent on suppliers to provide them.”

Healthcare executives are still exploring and learning about Linux and Open Source. In many

organizations, the knowledge of the Linux/Open Source value proposition still resides with the technicians, and not with the decision-makers.

### Future Growth

Most industry observers feel that healthcare's uptake of Linux can dramatically increase, pending advancements in several key areas:

- **Change.** As IT asset cycles run their course and servers and clients are up for replacement, some of those replacements will be based on Linux. Microsoft's new Vista operating system might also be a contributor, since Vista is a dramatic departure from Windows and is likely to cause retraining of office personnel on Microsoft applications. If extensive re-training is necessary, it might be enough to make healthcare organizations consider a migration to Open Source office applications, which are less expensive to license and more akin to what people are already used to with Windows.

- **Connectivity and Integration.** Linux/Open Source is already enjoying considerable success in healthcare network infrastructures and embedded systems in medical equipment. Meanwhile, the push for an electronic medical record (EMR) makes Linux/Open Source a logical choice for information sharing. In the future, using multiple core processors will enable organizations to handle multiple information services such as real-time video, scans, correspondence and other network applications.

- **Partnering for Delivery of Critical End Applications.** Healthcare end applications using Linux/Open Source remain in short supply, but "critical mass" vendors like IBM, Red Hat and Novell are starting to tip the scales to where both healthcare providers and application suppliers are engaged in Linux/Open Source projects with important deliverables.

"There is a big opportunity for healthcare organizations to participate in Open Source projects," said Red Hat's Tom Wunderlich. "If you get involved in Open Source and take the time to understand the benefits in licensing costs, choice, flexibility, standardized development, collaboration, and time to market, you will see the benefits first hand."

IBM uses a research lab and invites healthcare companies and vendors to test applications. Novell sponsors pilot programs for desktops. "Pilots like this will help vendors like Dell, which has a Linux desktop solution," said Novell's Bidleman. "It is a huge step forward just to introduce this desktop technology to healthcare organizations."

Partnering assures healthcare that the applications it adopts will be supported by credible

vendors. It also provides a “spawning ground” for large healthcare organizations to adopt applications—which in turn encourages smaller organizations to do the same. Growing adoption will inspire software providers to deliver Linux/Open Source versions of their products.

“More and more Open Source applications are being adopted by the market, and at some point using Open Source will be considered “normal” in healthcare,” said IBM’s Scott Handy. “The commercial Open Source vendor space is taking off, which will help with credibility and support issues. There is also the OHF bridge, which allows you to write an application or connection that simply “plugs in” to the bridge, even if the application resides on a legacy system.”

- **Virtualization.** Virtualization — the ability to consolidate physical servers by placing logical “instances” of these servers on a single hardware platform — is a very hot trend in healthcare and other industries. “Virtualization provides cost savings and redundancy. You save on hardware, staffing, and administration when you can run multiple instances of an operating system on a single machine,” said Tom Wunderlich. Virtualization is also an easy cost savings justification that can be used with upper management.

Virtualization with Linux/Open Source can be done on network servers or even on traditional mainframe platforms. For example, multiple instances of Linux/Open Source can be run on an IBM Z Series mainframe — a point not lost on large-scale healthcare organizations. “The mainframe is still being used as a data and transaction repository hub on networks,” said Scott Handy. “We’re seeing people connect mainframes into open platforms with the mainframe hub as a backend.”

### A Prescription for Success

A critical mass of Linux applications for healthcare providers is perhaps two years out, but Linux is already available in network infrastructure and several niche areas, and is poised to grow at a slightly greater rate than the overall market.

Organizations that can craft strategies for Linux/Open Source will be ahead in the game—as will companies that move forward with server consolidations and virtualization, which is greatly facilitated by Linux/Open Source. Organizations should be sure to partner with a reputable vendor that can provide extensive support. Initial deployments should be conducted in non-critical “pilots” before large-scale release.

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“Linux won’t be putting Microsoft out of business,” said Forrester’s Michael Gould, “But it has crossed the chasm to where it is no longer considered ‘risky.’”

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