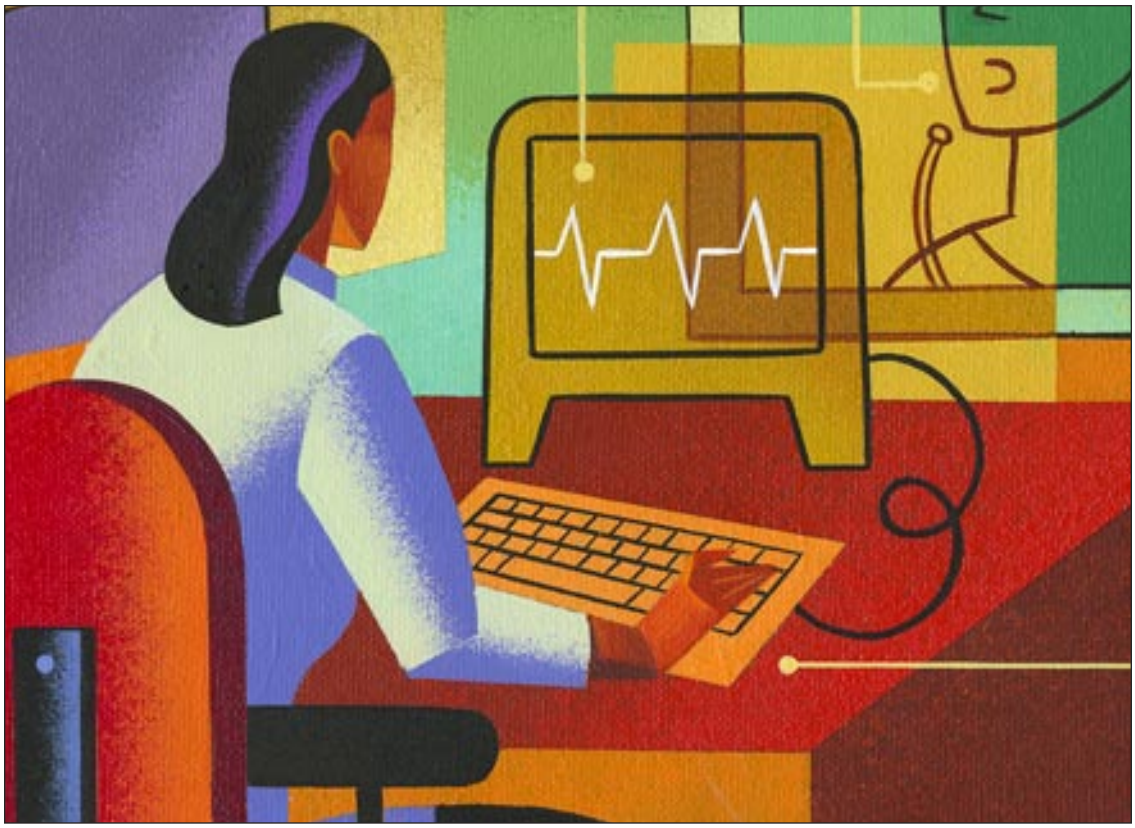

Open Source Software: A Primer for Health Care Leaders

ihealthreports

March 2006

Open Source Software: A Primer for Health Care Leaders

Prepared for
California HealthCare Foundation

by
Michael Goulde and Eric Brown
Forrester Consulting

ihealthreports

March 2006

About the Authors

Authors of this report include Michael Goulde, M.S., M.B.A.; Eric Brown, M.S.; John Rymer; Victoria Bough, M.S., M.B.A.; and David Hartzband, M.S., D.Sc., PostTechnical Research, Forrester Research.

About Forrester Research

Forrester Research is an independent technology and market research company that provides advice about technology's impact on business and consumers.

About the Foundation

The **California HealthCare Foundation,** based in Oakland, is an independent philanthropy committed to improving California's health care delivery and financing systems. Formed in 1996, our goal is to ensure that all Californians have access to affordable, quality health care. For more information about CHCF, visit us online at www.chcf.org.

The iHealth Reports series focuses on the effective adoption of IT in health care by analyzing the marketplace, inspiring innovation, and providing practical information on emerging technology trends.

ISBN 1-933795-03-4

Contents

I. Executive Summary

In the late 1990s, health care providers began to shift focus from automating individual departments to building integrated-care delivery systems, which required that hospitals and clinics also integrate the different types of IT systems used in their clinical departments. However, because conventional software presents many obstacles to achieving this goal, a number of health care IT leaders now are considering open source software as an alternative because, among other reasons, it allows different IT systems to operate compatibly, is nonproprietary and widely available at minimal cost, and gives health care providers more options and flexibility.

This report examines the development and distribution of open source software, and describes how it may help health care providers overcome the problem of incompatible IT systems that can disrupt the smooth exchange of information.

Background on Open Source

Clinicians' use of information systems and the ability of these systems to share patient data are two critical steps in the transformation of U.S. health care. But these accomplishments also pose difficult IT challenges — among them, how to share patient information beyond the walls of individual institutions and clinics, how to bring health care providers into regional networks that can easily and securely exchange that information, and how to expand the use of electronic medical records. Additional challenges include setting better standards for data formats and information exchange and making the cost of new technologies more affordable for physicians, most of whom work in small practices.

Addressing these challenges will require new approaches to many aspects of health care IT. The industry must rethink the way it develops patient-information software to reduce costs and increase flexibility, examine the way it distributes the software to providers, and look at ways to add value to commonly used software rather than producing competing, though functionally equivalent, applications. Health care IT is beginning to adopt open source software to address these challenges. Developing such software

involves a collaborative approach and volunteer labor, a political philosophy about users' rights, licenses that grant royalty-free copyrights to users, and revenues derived not from license agreements, but from support and integration services, as well as product enhancements.

There have been several attempts in the last decade to apply the open source model to health care. The Open Source Healthcare Alliance, Medsource, and an electronic medical records project sponsored by the American Association of Family Physicians began at the height of the dot-com and eHealth crazes of 1999–2001. But these efforts failed, for several reasons. First, they were premature, partly because the technology was not ready and partly because most health care providers were not ready for open source solutions. Second, the few individuals who spearheaded these ventures could not attract a sustainable core of developers to keep them going. And third, open source had not yet established credibility as a viable tool for accomplishing critical missions.

Today, however, the open source community in health care is more energized and has more of a track record on which to build. Spurred by a greater sense of urgency to adopt IT, health industry leaders are showing renewed interest in open source solutions. Among the highly visible projects gaining momentum nationally and internationally are OpenVistA, a patient information system in the United States; Care2X, an integrated practice management solution in Europe; and Health Infoway, a patient data-exchange venture in Canada. (See Appendix B for more information about open source health care projects.)

The potential advantages of open source software in health care are many. Anyone can use or modify the software with few restrictions, the cost for customers is minimal because developers generally volunteer their time, and revenues derive from services such as implementation and support rather than licensing, which means health care providers are more likely to gain direct value. In addition, the fact that no single vendor owns the software gives providers more options, enables them to customize software for their own particular needs, promotes public and foundation funding of software development, and ensures correct and timely implementation of standards, as there are no proprietary limitations. The creation of technology standards that define how information is structured, defined, and exchanged is critical because successful health care information exchange will depend on them.

By facilitating the adoption of standardized electronic medical records, open source software may contribute to the creation of regional health information networks, which exchange data and patient records. Access to source code will allow each region to adapt the software to its specific requirements without having to develop an entire software suite from scratch. In turn, regional innovation will filter back to the larger health care community, advancing the technology while minimizing costs.

Open source software is increasingly likely to become the dominant model for creating software to improve the quality of care in a cost-effective way because companies such as Red Hat, MySQL, and JBoss have demonstrated that the model is viable; because computer companies such as IBM, Hewlett Packard, and Sun Microsystems support the model; and because several health care-oriented open source projects have proved it works. Open source will not herald the end of commercial health care software suppliers, nor will it mean free software for everyone. But it will provide a reference point for true value and could become a powerful agent for managing price. Commercial offerings will have no choice but to follow this model of compatible information systems and data exchange.

The Roots of Open Source Software

Although open source is new to health care IT, it is well established in the software industry. The

roots of open source software date back to the early days of the computer industry. Among the most important landmarks was the creation in the 1970s of Berkeley Software Distribution—an alternative to AT&T's Unix operating system—using open source-like processes. Then, in the 1980s and 1990s, the key network protocols that underlie the Internet and World Wide Web were developed—and later freely licensed—using open source methods. The 1990s also saw the creation of the open-source Linux operating system, which demonstrated that open source processes could deliver commercially viable technology to the market. Today, open source projects have grown beyond their infrastructure roots to include many business and health care applications.

Open source software is different from conventional software in a number of ways. First, businesses in the open source arena derive most of their revenues from ancillary products and services rather than from software licensing. Second, while some open source projects are housed within a company, developing the software is a task more often shared by developers who either work for many different companies or for themselves. A high level of external contribution contributes to rapid evolution of, and innovation in, open source. Third, because open source software is easy to download, it can be evaluated, tested, and adopted much more rapidly than conventional software, sales of which require a long cycle. Fourth, the open source approach gives health care organizations much more flexibility because they can obtain software and services from many sources, not just one vendor.

The success of any open source product depends largely on the success of the community of developers who participate in its development. The characteristics of a successful formula are meritocracy (recognition of contributions to the effort based on value rather than the developer's title or employer), division of labor (volunteers take on specific assignments and work independently), involvement of those who use the software (they provide feedback and request that features be added), and strong leadership (either by the project founder or a steering committee). Successful communities for open source health care software have the same characteristics as all other successful open source software communities. In fact, open source software is well suited for health care, as it mimics the evidence-based health model; it, too, engenders better outcomes and continual improvement.

II. Background

During the last 20 years, the role of information technology (IT) in health care has evolved from being an administrative tool for billing and bookkeeping to becoming an important clinical tool for improving the quality and efficiency of health care delivery. In the 1970s and 1980s, IT helped large health care providers manage their business by automating financial records, insurance claims, payroll, and other back-office functions. In the early 1990s, information systems began playing a role in departments, such as laboratory, radiology, and pharmacy, and provided tools for nursing tasks, such as bed management. While these systems managed patient data within each department, the data remained largely unavailable to clinicians elsewhere in the organization because the information systems were incompatible.

Over time, Health Level 7 (HL7) standards emerged, enabling different computer systems to work compatibly. For example, billing information from individual IT systems could be routed to a centralized financial application, which allowed the creation of accurate and timely patient bills anywhere in a health care enterprise. However, patient medical records still were built from paper printouts and handwritten notes. The lack of electronic medical records severely limited the exchange of patient information.

Beginning in the late 1990s, integrated delivery systems such as Partners HealthCare and Sutter Health sought to bring together all of their disparate IT systems into one network that would provide a comprehensive view of a patient's clinical record on a single screen—at the bedside, in the physician's office, at the nursing station, in the radiology department, or elsewhere. These institutions have benefited from significant reductions in cost—for example, by eliminating duplicate diagnostic procedures—and from improvements in quality, most notably a substantial reduction in adverse drug events.

Industry analysts, clinical leaders, and senior government officials have heralded these two dynamics—clinicians' use of information systems and the ability of these systems to share patient data—as critical for the transformation of health care in the United States. The urgency of that transformation is bearing down as advances

in medicine offer increasing options, innovations in genomics create greater complexity, and an aging population threatens the viability of programs like Medicare.

Health Care IT Challenges

To meet looming challenges, health care must expand the scope of information sharing beyond the walls of individual institutions. Currently, patient care is provided by an unconnected collection of often competing facilities, including hospitals, physician offices, home health agencies, clinical laboratories, and rehabilitation centers. These providers need to be woven into regional networks that can easily share and exchange patient information in order to provide the best possible, and most cost-effective, care. Such networks will depend on health care IT.

The obstacles health care IT faces in achieving this level of integration cannot be overstated. To begin with, only a small percentage of physicians now use electronic medical records (EMRs), the most basic requirement for information sharing and management. Even where EMRs do exist, they often are stored in proprietary software formats that are not compatible with formats designed by competing suppliers. Standards are critical for achieving integration among EMRs.

Another significant obstacle is the expense of the software needed to create and manage EMRs, which providers often view as a low spending priority when compared to the need for new medical equipment and other treatment-oriented items. For small medical practices, which represent more than half of all physicians, the cost of health care-related software is a major burden; the additional cost of maintenance and support services puts it even further out of reach.

A Potential Solution

Addressing these challenges will require new approaches to health care IT in general and, specifically, new approaches to developing and distributing the software for the creation and exchange of patient information. Software for creating and managing EMRs must become more standardized, less costly, and easier to modify and implement. The infrastructure necessary to locate patient information and exchange it securely needs to be defined, built, and deployed as inexpensively as possible. A way to accomplish that goal is to focus development resources on a smaller number of equivalent software solutions.

Proprietary health care software has been one of the biggest barriers to achieving this objective. Companies have developed such software with few standards to guide them and no vehicle or motivation for collaborating with other vendors to ensure that products are compatible. The software has been expensive to develop because the market is relatively small; the costs have had to be passed on to the payers and providers who acquire and implement the applications.

How can the development of reasonably priced clinical software be promoted while laying the groundwork for the cross-communication necessary to support coordinated care delivery? In the last decade, a new approach—open source software—has emerged that holds promise. It is characterized by collaboration among individuals and organizations, sharing of intellectual property, and commitment to standards. Development of open source software originally focused on IT infrastructure, such as operating systems, networks, and databases. But now this approach is being used to develop and distribute a wide array of applications, including many for health care.

III. Open Source Software in Health Care

The health care industry dabbled with open source during the height of the dot-com and eHealth craze of 1999–2001. Searching the Web for "health care and open source" yields a number of sites around the world, each purporting to coordinate the development of open source EMRs, physician practice management packages, diagnostic image viewers, and other promising tools. However, most of the sites are no longer active. In the sobering years that followed, nearly all of these efforts to develop open source products lost their momentum.

The American Association of Family Physicians tried briefly to spearhead an open source EMR project, but it could not attract a developer community. While many hospitals remained committed to using open source software where they could find it, most notably the Linux operating system for the servers in their data centers, there was no significant adoption of an open source application in health care.

Recently, a more energized open source community, the proven success of open source in other fields, and renewed urgency to adopt health care IT have spurred industry leaders to revisit open source. In Europe, an open source project called Care2X has been working on an integrated practice management and EMR solution that has been translated into several languages, including Romanian, Portuguese, and Thai. The developer community for Care2X boasts more than 100 members. Another project, OpenHRE, is an open source effort largely funded by the U.S. Department of Health and Human Services to develop a secure health records access system in Mendocino County, California. Other similar efforts include ClearHealth, FreeB, and FreeMED. (See Appendix B for more details about open source projects in health care.) These are mostly grassroots efforts to create low-cost tools for physicians.

On a larger scale, government agencies (often the dominant health care payers) also are looking to open source as a vehicle for health care transformation. Their interests focus on the ability of IT systems to communicate as much as they do on lowering cost. In June 2005, Canada Health Infoway, which is funded by federal

and provincial grants, launched an open source initiative to create software that hospitals and health care IT software developers could use to ensure the reliable exchange of patient health records among institutions. According to an Infoway press release:

> *"As a reference tool for implementers and vendors, the Infoway Reference Implementation Suite will enable faster uptake of electronic health record interoperability standards endorsed by Infoway and our federal, provincial, and territorial partners," said Richard Alvarez, Infoway's president and CEO. "The tool will also help mitigate the risk for all jurisdictions and organizations who wish to put in place interoperable client registry systems."*

The U.S. government also sees value in making software assets more broadly available. Its VistA integrated hospital software package is already a public domain application. The OpenVistA project is based on VistaA and creates an open source mechanism that not only provides hospitals with the software but also transfers knowledge and expertise and builds long-term mutual support relationships between adopters and the rest of the worldwide VistA community.

These initiatives have sufficient momentum to suggest that open source is a viable approach to developing health care applications.

How Health Care Can Benefit

One of the greatest appeals of open source software for health care organizations is that it is easy to obtain. It can be downloaded from a number of Web sites that serve as repositories. Users' only obligation is to honor the open-source software license terms regarding distribution, derivative works, and modifications. They do not have to pay any software licensing fees. If a hospital, payer, or group practice can support the software internally, there is no cost other than the resources necessary to install and support it. Being able to view the source code helps developers understand how the programmer approached a problem, which often makes it easier for them to identify problems in their own programs that use the open source software.

Participants in open-source software development projects value a shared community and a common purpose. The goal of these communities is to develop software that can be used by anyone for any related purpose. Because developer time is often donated, cost is shifted from software development to providing services associated with the software. This shift makes the software easier to obtain and, because it is not proprietary, a wide variety of service options for implementing and supporting it often emerge as a result of supply and demand. Most importantly, though, open source software is vendor-neutral, which means physicians, hospitals, payers, and other health care organizations that use the software are not dependent upon any one vendor. Users can obtain it from many different sources, each of which competes on the basis of supplemental services and technical enhancements they may offer that extend a common and compatible software core.

The other benefits of open source software—low cost, flexibility, opportunities to innovate—are important, but independence from vendors is the most relevant for health care. A great deal of software development will be required over the next decade to build the technical infrastructure and applications necessary for EMRs that can be easily and securely shared by regional health information networks. To this end, having a vendor-neutral, open-source software platform to invest in is proba-

bly the best way to channel foundation and public sector funding into software development for the purpose of providing higher quality, less expensive medical care.

Experts estimate that only 15 percent of physicians — mostly those in large group practices — use EMRs. A national network that would enable sharing of such records is just a vision at this point. A key initiative of the newly created Office of the National Coordinator for Healthcare Information Technology is building a National Health Information Network to provide that infrastructure.

Few would argue against wider use of information technology to improve the efficiency and effectiveness of health care.[1] One study estimated that, in addition to improvements in health care itself, full implementation of national electronic health care information exchange and compatible IT systems could result in an annual net savings of $77.8 billion.[2] On the downside, another study estimated that the capital investment required to build a National Health Information Network would be $156 billion over five years.[3]

IV. Software Basics

Making software source code freely available is the foundation of open source. Software developers or programmers write source code using a variety of special languages to provide instructions that will ultimately tell a computer what functions to perform (see Table 1). Source code is written in a form that those trained in the programming language can read and understand. The source code is usually processed by a computer program called a compiler that converts it into another language—object code or binary code—that only computers can understand. Binary code also hides the intellectual property represented by the software.

Table 1. Source Code and Binary Code

Source Code Before Compiling	Binary Code*
`/* Hello World in C, Ansi-style */`	`000000 00001 00010 00110 00000 100000`
`#include <stdio.h>` `#include <stdlib.h>`	`100011 00011 01000 00000 00001 000100`

`int main(void)`
`{`
`  puts("Hello World!");`
`  return EXIT_SUCCESS;`
`}`
	`000010 00000 00000 00000 10000 000001`

NOTE: The binary code in this table does not accurately represent the source code before compiling.

Traditional software companies distribute their products only in binary form. For example, a provider of medical billing software, such as Cerner, does not have to reveal to its competitors the code that implements standards for electronic data interchange under the Health Insurance Portability and Accountability Act. By contrast, open source software developers distribute both the source code for their programs and the binary version. This enables another open source developer to use that same code without having to reinvent the wheel.

Data standards are extremely important in health care IT, just as they are in the rest of the software industry. In health care applications, standards specify how information is structured, identified, and conveyed. Either a committee defines the standards or they emerge as a result of widespread use in the market. For example, Health Level 7 (HL7) standards, accredited by the American National Standards Institute, provide guidance to organizations

regarding the exchange, management, and integration of electronic health care information. HL7 and other standards that are beyond the control of any individual vendor and upon which many parties agree are open standards. Such standards are preferable because no single vendor can manipulate a standard for its own purpose.[4]

Any kind of software, be it proprietary or open source, can support open standards. But open source software projects, as a matter of practice, generally support standards whenever and wherever they are relevant. For example, several current open source projects, like JEngine, OpenEMed, and HAPI, are implementing HL7 standards. These projects represent an efficient, low-cost way to apply health care information standards to software and to avoid multiple, duplicative development efforts.

Suppliers of health care software are expected to support relevant standards in their products. Having support for standards in software protects the investments that customers have made in hardware and software, and ensures that information can be exchanged among applications from different vendors.[5] As health care software products implement all relevant open standards, opportunities for proprietary differentiation decrease, customer leverage increases, and open source becomes more attractive.

As new technologies enter the market, open standards are created. The impetus for this comes from providers and payers who demand standards. A health care organization can gain advantage over competitors by innovating with a technology, and that fuels the demand for more even more standards.

The Roots of Open Source Software

It has taken time for the influence of open source to spread to health care. Today's open source software movement traces its roots to university computer science departments in the 1970s and 1980s. Several groups working at universities in California and Massachusetts wanted to create a version of ATT's Unix operating system that would not be subject to ATT's licensing terms. These groups believed that the licensing terms were overly restrictive, limiting where the software could be used and with whom the source code could be shared. The terms also imposed nondisclosure agreements, among other restrictions.

In response, a group at the University of California-Berkeley created an open source program called Berkeley System Distribution (BSD), using a collaborative process that included computer science researchers nationwide. Bill Joy, who later helped found Sun Microsystems, was a key participant in the project. Each researcher contributed code to BSD, and tapes of the program were freely distributed to other researchers. By 1991, this group had created a version of Unix without any proprietary ATT code.

At about the same time, a project called GNU Unix began at the Massachusetts Institute of Technology to develop another alternative to ATT Unix. Its founder, Richard M. Stallman, created the Free Software Foundation in 1988 and formulated some of the basic ideas about software freedom that underlie the open source movement. Open source software also sprang from work that went into developing the Internet and World Wide Web.

Open source came of age in the mid-1990s, when elements of earlier projects were incorporated into the most widely known open source venture, the Linux operating system. Like many of those previous projects, Linux grew in a university setting. Its brainchild was Linus Torvalds, a student at the University of Helsinki, who enlisted hundreds of developers from around the world to produce a product that today has all but replaced Unix.

Now there are thousands of other open source software projects that adhere to open source principles, such as free distribution of source code and

collaboration among programmers. They attract programmers from many countries who create and contribute code free of charge and without compensation. Their common goal is to generate new software. Many recent open source projects have focused on creating important health care-related software by applying the same concepts that projects like Linux used with great success.

The Importance of Community

Successful development of open source software for health care will require viable developer communities. Such communities, which share an interest in a particular type of software, are the engines that drive open source projects. They may be organized around one or more projects. Some have a clear governance structure, with project management committees and project leaders, while others are more loosely structured. However, most share common characteristics, including a:

- **Meritocracy.** In some ways, an open source community is like a club. Participants gain admission by proving their interest in a project, their skills, and their commitment through participation. Merit includes the quantity, frequency, and quality of contributions. Leaders of the community grant access permissions and status to developers who have demonstrated merit.
- **Division of labor.** An open source community typically parcels out the work to various members. Some focus on specific software functions, others on testing and bug-fixing. All contributions are valued.
- **User involvement.** While communities do not expect companies or individuals who use their software to contribute code to the project, they greatly appreciate contributions, such as bug reports, installation tips, and even documentation, in exchange for free software downloads.

Not all communities survive. Indeed, among the 37 health care-related projects listed at SourceForge.net, a popular repository for open source software, almost half either were dead or have not been active for several years. Projects sometimes fail because the leader loses interest and moves on to other things, or the project is superseded by a similar, more effective one.

Open source software began as a novelty, of interest to only a few programmers. But a combination of factors has expanded its scope to include a wide variety of applications and industries, including health care. Open source software has moved from computer networks, operating systems, and software that provides the infrastructure for business applications into arenas such as EMRs, practice management, and billing. It has even migrated to mobile phones, personal digital assistants, and other smart devices, all of which have a place in health care.

In a January 2005 survey, more than 50 percent of 137 North American IT decision-makers indicated they were using some type of open source software; another 19 percent planned to begin doing so by the end of 2005.[6] Those findings do not mean that open source software is replacing traditional software, because most companies are using the open source variety only for certain applications. But open source software is gaining a foothold in health care as health care organizations and IT suppliers recognize its value.

Open Source Software Is More than Source Code

The term open source is used in a variety of contexts to describe several different things. In addition to the software that is developed from open source code, it also refers to a:

- **Software licensing model.** Each open source software program comes with a license that grants royalty-free copyrights to the user. Many different licenses may be used; they vary in their

terms and conditions regarding derivative works, patents, and other issues. (See Appendix C.) Health care organizations need only concern themselves with the specifics of the license if they intend to modify the program or incorporate it in some other software they may be developing.

- **Political philosophy.** The basic philosophy of open source software is that users should have the freedom to copy, use, and distribute it. This philosophy is consistent with health care's practice of broadly sharing innovation in medical care delivery throughout the health care community rather than vigorously protecting innovation as a valuable intellectual property. But open source software is not necessarily free of cost; some open source licenses permit sales of the software as long as the source code is made available.
- **Software development model.** Open source has evolved a model for software development that emphasizes collaboration among a community of people who share common interests. Frequent releases are also typical of this model. The collaborative approach is similar to peer review, a prevalent practice in medical research.
- **New business model.** New business models are emerging based on revenue generated from things such as support services, consulting services, and product enhancements rather than the software itself. Customers can acquire the source code for free, but they pay for other products and services.

V. How Open Source Software Differs from Other Software

An open source software license grants users the freedom to view, modify, and distribute the source code. The software creator, who conveys rights to licensees, retains the copyright. Depending on the type of license, the user may be obligated to freely redistribute the software and any modifications, or incorporate the open source software in a product and charge for it. A good example of open source health care software is OpenVista, a health care information system distributed with a license that allows unlimited use at any number of facilities.

Public domain software, which includes freeware (available at no charge) and shareware (available for a small fee paid to the author), is different from open source software. The former is distributed in binary form only and no copyrights, including the right to modify the software, are assigned; its use is unlimited. Health care organizations generally should avoid freeware and shareware because it does not include technical support or any assurances that development is continuing.

The most significant difference between open source software and proprietary software is that anyone can view the former's source code. Thus, knowledgeable persons may enhance or improve the program. A health care systems integrator or health care IT unit can modify and extend open source software as necessary for a specific situation or adapt it to changing regulations or new specifications. In contrast, the source code in traditional software is secret; purchasers are totally dependent on the vendor to make modifications.

Software companies make money by selling the right to use the intellectual property embodied in their product, be it Microsoft Windows, Intuit Quicken, or Adobe Photoshop. The cost to create these products is largely a function of the programmers or contractors who are employed to write the source code. Customers pay to use the software under license from the company, which retains its rights to the product, and they purchase a support contract from either the company or one of its certified partners to receive help installing, configuring, and maintaining the software. Support services are another important source of revenue for software manufacturers and a primary revenue generator in the open source world.

Because software does not wear out, software companies strive to create obsolescence by adding new features to their products and encouraging customers to purchase the upgraded versions. For example, new requirements for prescription labeling or a new approach to tracking drug interactions may spawn a new version of a pharmacy software package, available only by purchasing an upgrade. New versions of software entice new users to license it, and entice existing users to continue buying upgrade licenses and support services.

How Open Source Is Created

Open source software is authored by small communities of developers who are committed to advancing health care IT but are not directly compensated financially for their efforts. Health care software projects often are led by the person or persons who originally conceived the project. David Forslund, founder and leader of the OpenEMed project, is a good example. He reviews contributions from other developers and incorporates them into the program. In many projects, contributors are elevated to the status of committer, which authorizes them to add their own contributions to the program code. The process of reviewing the work of contributors and elevating their privileges is known as meritocracy.

Traditional vendors, in contrast, employ engineers to design software and programmers to write it. There may be a senior architect who designs the product. Little input comes from outside and all development depends on available resources. Programmers sign confidentiality agreements with the employer, who owns whatever the programmers produce. If they leave the company, they are enjoined from taking the code they created with them. The vendor holds the copyright to all works.

Part of all software development is testing. In the open source software community, some participants contribute by testing the work of other developers. Anyone can download the software, test it, and contribute bug reports or even fixes. Testing feedback is not limited to programmers; in the health care arena, feedback may come from hundreds of physicians, hospitals, and payers, which increases the probability of finding bugs so developers can repair them.

Developers or a separate quality assurance group does the testing for software vendors. While a company may make early, or beta, versions of a product available to outsiders for testing, those versions are usually restricted to a few parties—typically selected, existing customers—and their access is controlled under terms of nondisclosure agreements. There is some evidence that the open source approach exposes problems earlier and leads to more rapid fixes than the traditional model does.

Distribution of Open Source Software

Open source software is freely downloaded from many Web sites, while distribution of traditional software is controlled by the supplier. Health care organizations can easily and rapidly access and try open source software and obtain new versions. The cost borne by the organizations or their systems integrators is low. Moreover, open source software projects do not place restrictions on Web sites that wish to make their software available for downloading, with the exception that no fees be charged. Web sites may be managed by the open source software project, such as OpenEMed.org and OpenHRE.org, or by a third party, such as SourceForge.net.[7] Although there are several open source projects related to health care at SourceForge.net, most such software is maintained at software-specific sites.

Buyers acquire proprietary software from the vendor or from one of its authorized resellers in binary form.[8] Downloading is sometimes available for free, limited use, or customers may be able to view a demo version, or, after a fee is paid, to get the licensed version. The vendor keeps track of who has downloaded the software or purchased a software license. The person who installs the software must accept the commercial license that comes with to

complete the installation, unless the software is a time-limited demonstration or evaluation version. Usually the software can be installed only on one computer, unless a license for multiple computers is purchased. These factors introduce delays and cost into the process.

Doctors, hospitals, pharmacies, and payers are more or less at the mercy of vendors of commercial health care software, which leaves many of them feeling like they are paying too much. However, they typically do not switch to another vendor, either because a substitute product is lacking or because doing so would be expensive. In the absence of alternatives, it is a seller's market. Even when there are alternatives, the cost of switching to a competing proprietary product may be prohibitive if the old and the new software are not compatible.

Given the specialized nature of many health care applications, often there are few other suppliers of a particular type of software and, therefore, few choices. An advantage of open source software is that many suppliers can distribute the same application; health care customers need only choose the best vendor of related services.

Licensing for Open Source

Open source software licensing gives users much more freedom than commercial licensing does. The latter carries many restrictions, such as where software can be used and how many copies can be made. This severely restricts health care organizations' flexibility in terms of how and where they deploy an application. Open source licenses, on the other hand, actually encourage broad usage. When suppliers roll out open source software at physician offices, clinics, or hospitals, they need not worry about complex licensing restrictions.

U.S. copyright law is the basis for open source licenses. It grants copyright holders five exclusive rights: to copy, distribute, perform, and display the work, and to make derivative works. An open source project owns the software copyright. Licenses grant certain nonexclusive rights to licensees. Using one of various open source licenses that have been vetted by the Open Source Initiative (OSI), an ad hoc, self-appointed arbiter of open source licenses, the copyright holder grants to the software user some combination of rights. An open source health care project typically would use one of the OSI-approved licenses (for example, a general public license or a lesser general public license) to ensure that its software is widely available, and avoid other OSI-approved licenses, such as a Berkeley Software Distribution (BSD) license, that allow a vendor to charge for software.

There are two basic types of open source licenses: unrestricted and restricted. Each applies in certain health care circumstances. Unrestricted licenses are a great way to promote broad use of a new technology very quickly, such as implementing an important new privacy standard. They do not limit the distribution of derivative works or the use of open source software in commercial software. The Apache and BSD licenses are examples.

Restricted licenses are ideal for maintaining the integrity of software code and preventing splinter efforts. The restrictions ensure that the code will always be freely available. This enables systems integrators and the hospitals, clinics, and practices they support to have a reliable code base. The Free Software Foundation has coined the term copyleft (vs. copyright) to refer to restrictive licenses, like the GNU general public license (GPL), which requires that modified versions of a GPL program be free software as well.[9]

Who Supports the Software?

Software, particularly the kind that large group practices, clinics, clinical laboratories, hospitals, and insurers use to run their operations, is complex. Health care organizations need help installing, configuring, and getting new software to work seamlessly with other software they already use,

especially given that most of them lack sufficient IT staff. Over time, problems with the code, or bugs, are discovered and must be fixed. Also, small enhancements to the software often are released between new version releases. In the commercial sector, software vendors or their partners handle these situations through support agreements and maintenance contracts.

Open source health care software requires these same services, which are available from e-mail lists and companies. The email lists comprise developers and users of open source software in health care organizations. The companies either sell support for one open source product or for multiple products, or they sell support for open source software as well as traditional software.

VI. Industry Perspectives on Open Source

The business of open source software began beyond the walls of traditional software vendors. Over time, companies such as Red Hat and JBoss built business models around open source products and services. Eventually, in response to the growing importance of open source, many software vendors developed open source strategies, which ranged from embracing open source to arguing vociferously that it was bad for the industry. A similar pattern is emerging in health care. Some vendors of software for patient management, EMRs, claims processing, health care information systems, and the like are incorporating open source into their product and service strategies, while others are rejecting the approach and defending their proprietary products.

Open source is a direct challenge to the foundation of the proprietary software model in which software represents the intellectual property assets that generate major revenues for companies. However, many proprietary vendors realize they must accommodate open source principles to some extent or health care organizations that have embraced open source will perceive them as obstructionist. Even Microsoft has given ground to open source—by allowing selected customers to apply for admission to its Shared Source program, which lets them view source code for selected products.[10]

Adapting to Open Source

Health care software vendors can adapt to open source in various ways. At a minimum, by supporting common data standards such as HL7, proprietary software can exchange information with open source applications. An example of more explicit support for open source software is OpenEMR, an open source EMR package that Synitech originally developed as a proprietary product but subsequently donated to an open source community to attract developer support and expand its adoption. Synitech still provides services to health care providers who use OpenEMR.

Another strategy for accommodating open source is dual licensing, which is simultaneous licensing of software under both open-source and proprietary licenses. Uversa takes this approach.

It offers ClearHealth, a medical software suite for large and small clinics and physician practices with multiple facilities. ClearHealth includes modules for scheduling, billing, EMR, security for complying with the Health Insurance Portability and Accountability Act, accounts receivable, document management, and more. Uversa makes ClearHealth available under either an open source license at no cost but without any support services, or under a commercial license with full support.

A growing number of commercial vendors base their business models on development and distribution of open source software, although few are in health care. These companies pursue different business and community-development models. In the future, firms that offer open source health care software are likely to adopt these approaches.

Some open source companies, like JBoss and MySQL, control the development community and almost all code that goes into the product their employees have generated. Nevertheless, such software is available in source code form under an open source license. These companies also distribute their software under commercial licenses that grant different benefits to customers under different terms, which might include enhanced functionality or support services. Their long-term success will depend on whether potential customers are willing to pay enough for the enhanced functionality and support services so the companies can prosper. Red Hat, a public company that supplies the open source operating system Linux, has been profitable for several years, proving the viability of this business model.

Computer suppliers such as Apple, Dell, Hewlett-Packard, IBM, and Sun Microsystems play an important role in the health care industry. They provide computer systems for doctor offices, hospitals, and clinics, and also the infrastructure for large payer systems. Their support for the adoption of open source software in health care is important. They all support Linux, although their distribution approaches vary. Dell's involvement with open source software to date has been limited to supporting Linux, JBoss Application Server, and MySQL database products on its computers. IBM, Sun, and, to a lesser degree, Hewlett Packard have software businesses that are impacted by open source software, which is a direct threat to IBM's and Sun's extensive software portfolios. All three support Linux on their computers.

Open source software has had some success in horizontal applications, or applications that are useful in many different industries. These applications include enterprise resource planning and customer relationship management. But open source has had less impact vertically, in applications specific to one single industry, such as health care.

The potential market for vertical applications is smaller than that for horizontal applications. Furthermore, the health care industry historically has not made IT a top priority, so it lags behind other, more IT-intensive industries, such as financial services and Internet businesses, such as Google, in adopting open source.

Greating Communities with a Common Goal

Another reason open source has had less impact in health care is that many of the standards necessary to guide the development of relevant software are still being developed. But where those standards do exist, open source software is a good candidate for implementing them at low cost because there will be less motivation for proprietary vendors to invest in competing products. Vendors will have an incentive to adopt open source software and provide value-added services and support.

The key to successful open source health-care applications will be viable communities in which many companies or health care organizations participate, sharing a common goal of creating inexpensive software for all to use and where issues of competi-

tive advantage or proprietary differentiation are minimized. Participants will come from universities, government, systems integrators, and various vendor organizations that focus on health care.

Expanded use of open source in health care has direct implications for information exchange. With open standards in place and an effective open source community established, collaboration could fill the gaps in EMR technology and network infrastructure. A health care-focused open source community would require participation by business and IT management, as well as developers. It also would be an attractive vehicle for funding sources and software suppliers.

Physician groups, hospitals, clinics, and other health care organizations that use any kind of software are potential customers for open source. These professionals need many different types of software—to run their computers, to protect their networks, to store and manage patient information, and to provide the foundation for other operational and clinical applications.

Large health care organizations have IT staff who develop many software applications on their own. Other organizations rely on ready-made applications, or commercial off-the-shelf (COTS) software. The decision to develop software internally or purchase COTS software generally depends on a company's size and the complexity of its software needs.

Pros and Cons of Open Source

Health care organizations that develop their own applications using their own programming staff find open source software attractive for four reasons. One is the low cost and ease of acquiring the software. Another is the growing selection of open source projects from which to choose, which frees organizations from dependence on any one supplier. The third is wide support for open source standards, making it easy to switch from one project to another. Finally, the ability to view and modify the source code offers more flexibility.

On the other hand, these organizations often must arrange their own project support. They face the risk that the community developing the open source software may become inactive and cease enhancing it. They also are concerned about requirements for redistributing derivative works and modifications, which could place them in the position of making proprietary intellectual property available to competitors.

Small health care organizations, such as group practices, clinics, and most hospitals, do not develop any software themselves. They may engage consultants to customize standard, off-the-shelf applications. For them, the benefits of open source are the lower acquisition cost of the many pieces of software they need to build a complete IT environment and the flexibility and lower cost their consultants achieve. Also, by relying on open source solutions, they reduce the risk of getting locked into proprietary software, which gives them greater flexibility and more options in the future.

VII. The Impact on EMRs and Regional Networks

Open source initiatives will have the greatest impact in two specific areas: basic EMR systems and regional health information networks. Already there are a number of open source EMR projects internationally whose goal is to develop an adequate, inexpensive product for many small physician groups and solo practices. In the United States, hundreds of practice management systems have emerged in the last decade, each with its own handful of local resellers to serve local physicians. In an open source EMR model, physicians will continue to turn to small local services firms for IT outsourcing, but the EMR systems they install will be largely derived from the same open source base, thereby ensuring that the systems are compatible and reaping the rewards of one large development effort. OpenEMR and VistAOffice are examples of such nascent efforts. Similarly, small community hospitals could turn to solutions based on OpenVista.

The forthcoming National Health Information Network will encompass an estimated 100 to 200 regional networks, each with its own infrastructure for access control, clinical integration, database management, record location, messaging, and data presentation. Software cost is an issue for those involved in this undertaking, but by all measures, systems integration costs—the labor it takes to connect all of the computer systems together)—will dwarf the price of software and hardware.

Open source products such as OpenHRE can provide some relief on the software-cost side, but their greatest benefit is the openness and flexibility they offer. Each connection between each computer system in those regional networks presents a unique challenge. The open source approach will enable individual regions to adapt IT to their own special needs and not be beholden to multiple commercial software vendors. As each region finds innovative ways to resolve issues, it will plow the fruit of that effort back into open source code base, sharing it with all other regions. Instead of competing, regions will work cooperatively to weave the national network.

VIII. Conclusion

Conditions are fertile for open source solutions to take root in health care. Awareness of open source development and business models has become widespread among health care software and services companies. Open source software that could provide the underpinning for health care applications has reached maturity. Software companies such as Red Hat, MySQL, and JBoss have proved the viability of open source business models. Major suppliers like IBM, Hewlett-Packard, and Sun Microsystems have lined up in support of open source software, and both federal and state government agencies have made clear their support for this approach. Several pioneering health care-oriented open source projects have provided proof of concept.

Garage-shop efforts to save the world through free medical software are history, replaced by mature, rational efforts to create shared components that work with each other and to promote a common understanding of essential data structures in a context large institutions will nurture. Health care businesses have an opportunity to take the lead and drive the shift to this model.

The emergence of open source software for health care will not herald the end of commercial vendors, nor will it mean free software for everyone. But it will provide a reference point for the true value of software and, as such, will prove to be a powerful agent for managing price. Commercial packages will have to demonstrate equivalent support for standards and provide significant value beyond that offered by open source solutions to command any kind of premium. Open source solutions based on open standards, and those that implement those standards, will provide the lead model for commercial packages to emulate.

Thanks to vendor neutrality, openness, and support for standards, open source solutions—crafted through collaboration and consensus, and tested in practice—will become the model for how health care IT captures patient information, manages it, shares it securely, and uses it to support high-quality patient care.

Appendix A: Glossary

Apache Software Foundation. A private, nonprofit community of developers and users that provides support—hardware, communication, and business infrastructure—for Apache open source software projects. www.apache.org

Apache Web Server. An open source software product that runs most Web servers. Development of the Apache Web Server spawned the Apache Software Foundation.

Application software. Software designed and written for a specific personal, organizational, or processing task, such as database management, spreadsheets, payroll, or inventory.

Berkeley System Distribution (BSD). An open source version of ATT Unix created at the University of California-Berkeley beginning in the 1970s.

Binary. A numeric system comprising 1's and 0's. Machine language processed by a microprocessor is in the form of 1's and 0's. Ready-to-install software products often are called binaries.

Compile. A process that uses a software program to convert source code into object code, which a computer can process. After the logic and instructions of an original program have been compiled, people cannot read them.

Eclipse Foundation. A private, nonprofit open source community whose projects focus on building the tools that software developers can use to create software. eclipse.org

Free Software Foundation. A nonprofit created in 1988 by Richard M. Stallman at the Massachusetts Institute of Technology that is the leading proponent of software freedom. www.fsf.org

GNU. A recursive acronym for GNU's Not Unix, which is a program created at the Massachusetts Institute of Technology as an open source version of ATT Unix.

GNU general public license (GPL). An open source license, created by the Free Software Foundation, that most open source software uses. It grants the right to view, copy, modify, use, and redistribute software. However, any modified software or software that uses GPL software must also use the GPL license. This feature protects software from abuse of freedoms but also limits its commercial potential.

GNU lesser general public license (LGPL). Designed for software libraries, it is a derivative of the GPL. But unlike a software program licensed under GPL, one licensed under LGPL can be incorporated into a proprietary program.

Infrastructure. The hardware and software necessary to support business applications. Infrastructure includes computers, networks, databases, and application servers.

JBoss. A commercial software company that distributes its product, the JBoss Application Server, in source code or binary form under an open source or commercial software license. JBoss is a dual license business model. www.jboss.com

Libraries. Software that contains routines and functions for use and reuse by other software.

Linux. A Unix-like open source operating system. Linus Torvalds, a Finnish college student, created Linux in the early 1990s. It is the most successful open source project to date.

Microprocessor. The central processing unit in a computer. It is a circuit of transistors and other electrical components on a chip that can process programs, remember information, or perform calculations.

Middleware. Software that provides a bridge between the operating system of a computer and the various business applications it runs. Middleware enables data and requests to be exchanged between different applications.

MySQL AB. A commercial software company that distributes its database product, MySQL, in source code form under an open source or commercial license. Many Web sites use MySQL, along with Linux and the Apache Web Server. www.mysql.com

Network. A connection among two or more computers that allows them to exchange information using standard protocols. The largest computer network is the Internet.

Object code. Software instructions that are compiled as an intermediate step between source code and binary code. The instructions read source code and then create binary code, which a computer can understand.

Open Source Initiative. An organization founded in 1998 by Bruce Perens and Eric S. Raymond to promote

open source software. They coined the term open source software at that time. www.opensource.org

Open Source Development Labs. A consortium that guides the development of Linux, a Unix-like open source operating system created by Linus Torvalds in the early 1990s. www.osdl.org

Open source project. One or more software products developed by an open source community. The terms project and product are used interchangeably.

Operating system. The software that tells a computer what to do after it is turned on—for example, to display graphics, handle user interaction, read and write to disk and to the network, and run programs such as word processors and databases. Operating system instructions are processed by the computer's microprocessor.

Protocol. In this report, protocol refers to network protocols, which are rules governing how applications and computers communicate on a computer network.

Software Freedom Law Center. A private company that provides legal representation and other law-related services to "protect and advance free and open source software." www.softwarefreedom.org

Source code. The instructions written by a software programmer in one of many hundreds of programming languages. Other programmers read the source code to determine what the original programmer was trying to accomplish. It must be converted into a form that a computer can process.

Appendix B: Open Source Health Care Projects

Care2X. An "integrated healthcare environment" with four components: hospital information system, practice management, central data server, and health exchange protocol. Software is distributed under the GPL license. A community of 100 developers in 20 nations is developing Care2X. www.care2x.com

ClearHealth. A suite of medical software for large and small clinics. It handles functions such as scheduling, billing, EMRs, security for compliance with the Health Information Portability and Accountability Act, accounts receivable, and document management. Uversa, a private company, developed ClearHealth and makes it available under an open source general public license with or without support. Information about ClearHealth, as well as FreeB (medical billing), OpenNHIN (an open source prototype for the National Health Information Network), and other open source projects, is available at Open Enterprise Platform. www.op-en.org

FreeMED. An open source practice-management and EMR system. It is based on an episode-of-care model and licensed under a lesser general public license, LGPL. The FreeMED Software Foundation is a vehicle for ongoing development of FreeMED software. www.reemed.org

OpenEMed. A set of open source software components designed specifically for health care information services. These components can be assembled and configured in different ways to accomplish a variety of tasks. OpenEMed is built around HL7 and other standards. openemed.org

OpenHRE. A project whose mission is to foster development, distribution, and support of standard record locater, health record exchange, and access control services as open source software. These services are components of a National Health Information Network. Currently the effort is a collaboration between a commercial software company, Browsersoft, and the Alliance for Rural Community Health. An early version of OpenHRE is available for download at its Web site. www.openhre.org

OpenVista. An open source implementation of VistA, a health care information system the U.S. Veterans Administration uses at its clinics and hospitals. Although VistA is in the public domain, it is based on a proprietary programming language, which prevents it from being truly open source. OpenVista is an open source application based on that language. Information about OpenVista is available at sourceforge.net/projectds/openvista.

Appendix C: Open Source Licenses

There are nearly 60 open source licenses that the Open Source Initiative (OSI), the de facto arbiter of such licenses, has approved. OSI coined the term open source software, defined it, and uses that definition to determine whether a license meets OSI criteria for approval.

Licenses vary according to the rights and responsibilities they grant to persons who use licensed software. All open source licenses govern distribution of source code and the right to modify it. But they differ in terms of what licensees are obligated or entitled to do with modifications they make to the software. These obligations range from distributing modifications for free to being allowed to charge license fees for the modified software or other derivative works.

Commonly used open source licenses are:

- **GNU general public license (GPL).** Nearly 70 percent of open source software projects use GPLs. The license permits modifications and derivative works, but those that a user distributes must be returned to the open source community. The lack of clarity in the definition of what constitutes distribution has been one of the greatest criticisms of the current version of GPL (Version 2.0).
- **GNU lesser general public license (LGPL).** The LGPL allows a computer program, or library, to be accessed by another program without being included in it. This allows the first program to retain whatever license its creator intended.
- **Berkeley Software Distribution license (BSD).** The BSD license is very liberal, allowing almost any use of the software in any form, as long as the copyright notice is retained and displayed.
- **Apache license.** Projects developed under the auspices of the Apache Software Foundation use this license. It allows as much freedom as the BSD license, but it does not require that the copyright notice be displayed.

Table 2. Summary of License Conditions

License Conditions	GPL	LGPL	BSD	Apache
Copyright notice must be attached	X	X	X	
User can modify code	X	X	X	X
User can create derivative works	X	X	X	X
User must return modifications	X	X		
User can charge for derivative works			X	X
User can distribute derivative in binary form		X	X	X
GPL-compatible	X	X		

Appendix D: Open Source as Defined by the Open Source Initiative

Open source does not just mean open access to source code. The distribution terms of open source software must meet these criteria:

1. **Free redistribution.** The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution that contains programs from several different sources. The license shall not require a royalty or other fee for such sale.

2. **Source code.** The program must include source code and must allow distribution in source code as well as compiled form. When some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for a reasonable reproduction cost, preferably by downloading it from the Internet without charge. The source code must be the preferred form a programmer uses to modify the program. Deliberately obfuscated source code is not allowed, nor are intermediate forms, such as the output of a preprocessor or translator.

3. **Derived works.** The license must allow modifications and derived works, and must allow them to be distributed under the same terms as those in the license of the original software.

4. **Integrity of the author's source code.** The license may restrict source code from being distributed in modified form only if the license allows the distribution of "patch files" with the source code so the program can be modified when it is built. The license must explicitly permit distribution of software built from modified source code. It may require derived works to carry a name or version number different from that of the original software.

5. **No discrimination against persons or groups.** The license must not discriminate against any person or group of persons.

6. **No discrimination against fields of endeavor.** The license must not restrict anyone in a specific field of endeavor—for example, someone in a particular business or someone doing genetic research—from using the program.

7. **Distribution of license.** The rights attached to the program must apply to everyone who gets the redistributed program, without those parties needing to execute an additional license.

8. **License must not be specific to a product.** The rights attached to the program must not depend on the program's being part of a particular software distribution. If the program is extracted from that distribution and used or distributed within the terms of the program's license, all parties to whom the program is redistributed should have the same rights that were granted when the software was originally distributed.

9. **License must not restrict other software.** The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed in the same medium be open source software.

10. **License must be technology-neutral.** No provision of the license may be predicated on any individual technology or style of interface.

Endnotes

1. For example, see testimony by the U.S. Government Accountability Office to the House Committee on Government Reforms, "Health Care Continued Leadership Needed to Define and Implement Information Technology Standards." Statement of David A. Power, director of information technology management issues, September 29, 2005 (www.gao.gov/new.items/d051054t.pdf).

2. Walker J, Pan E, Johnston D, et al. "The value of health care information exchange and interoperability." *Health Affairs.* Web Exclusive, January 19, 2005 (content.healthaffairs.org/cgi/reprint/hlthaff.w5.10v1)

3. Kaushal R, Blumenthal D, Poon EG, et al. "The costs of a national health information network." *Annals of Internal Medicine.* 2005;143(3):165–173.

4. According to wikipedia.org, "Open standards are publicly available specifications for achieving a specific task. By allowing anyone to obtain and implement the standard, [open standards] can increase compatibility between various hardware and software components, since anyone with the necessary technical know-how and resources can build products that work together with those of the other vendors that base their designs on the standard."

5. A recent example is the Commonwealth of Massachusetts, which requires that document-creation software use a standard called the open document format created by the OASIS Consortium. Microsoft, the commonwealth's supplier of office software, does not currently support this format.

6. For more information about this survey by Forrester Research, see "Open Source Usage Up, But Concerns Linger" in the June 23, 2005 issue of *IT View Trends* (www.forrester.com/Research/Document/Excerpt/0,7211,37197,00.html).

7. Apache.org is the Web site for the Apache Software Foundation, a nonprofit organization that focuses on application infrastructure software. The Web site contains all Apache open source projects, including source code, binary code, works in progress, documentation, and more. The nonprofit Eclipse Foundation, which focuses on development tools, provides all of its software at eclipse.org. SourceForge.net is home to more than 100,000 open source projects and provides services such as storage and email lists for these ventures.

8. In some instances, vendors allow customers to view the source code of its products. For example, under a Microsoft program called Shared Source, customers can apply for permission to access the source code for some of its products. They are not permitted to modify the program or compile the source code for use.

9. The OSI has approved nearly 60 open source licenses. It coined the term open source software, defined the term, and uses its definition to determine if a license meets its criteria for approval. Licenses vary according to the rights and responsibilities they grant to users. Distribution of source code and the right to modify it are addressed in all open source licenses. Licenses differ in terms of what licensees are obligated or entitled to do with modifications they make to the software. These obligations range from distributing modifications for free, to being allowed to charge license fees for the modified software or other derivative works.

10. More information about Microsoft's Shared Source program is available at www.microsoft.com/sharedsource. Shared Source has many subprograms, which suggests that Microsoft is not willing to allow all customers to view all source code for all products. Before customers can gain access to the source code, they must sign an agreement that includes limitations.

References

1. DiBona C, Ockman S, Stone M, et al. 1999. *Sources: Voices from the Open Source Revolution.* Sebastopol, CA: O'Reilly Media.

2. Rosen L. 2004. *Open Source Licensing: Software Freedom and Intellectual Property Law.* Indianapolis, IN: Prentice Hall PTR.

California
HealthCare
Foundation

476 Ninth Street
Oakland, California 94607
Tel: 510.238.1040
Fax: 510.238.1388
www.chcf.org