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Developing an Information Systems Infrastructure with Open Source Software

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Beaumont Hospital, one of Ireland's oldest, employs 3,000 staff and has substantial IT requirements. As with many other organizations worldwide, Beaumont's IT budget has significantly decreased since 2000 in the wake of Y2K preparation costs. In 2003 alone, it faced an opening €17-million budgetary shortfall. The overall IT environment has heterogeneous application platforms and associated servers, with approximately 1,000 desktop machines to support. Approximately

one-third of these are bordering on obsolete, with 64 Mbytes of RAM or less and clock speeds of less than 300 MHz.

To address the hospital's IT needs, Beaumont is developing and deploying open source software (OSS) systems. Until now, most OSS deployments have been in invisible infrastructure applications running on back-office servers (such as GNU/Linux or Apache). Beaumont has chosen to develop its overall information systems (IS) infrastructure by deploying more visi-

ble desktop and front-office OSS applications in addition to GNU/Linux and Apache.

By implementing OSS, Beaumont expects to save over €20 million over five years. These results are significant in that few studies have thus far quantified the savings from OSS deployment. In addition, the extra functionality available in the OSS systems often allows for a richer feature set overall.

IS infrastructure

Beaumont Hospital is implementing its proposed IS infrastructure in two phases. Figure 1 outlines this plan. It reveals a move away from a legacy-application architecture toward a Web-based service-oriented architecture. In Phase 1 (the yellow-shaded areas in the figure), we extensively used OSS components to support this overall architecture. However,

In the wake of budget shortfalls, Ireland's Beaumont Hospital is addressing its information systems infrastructure needs by turning to open source software. With a two-phase approach, the hospital's IT department is upgrading its application platform and associated server environment.

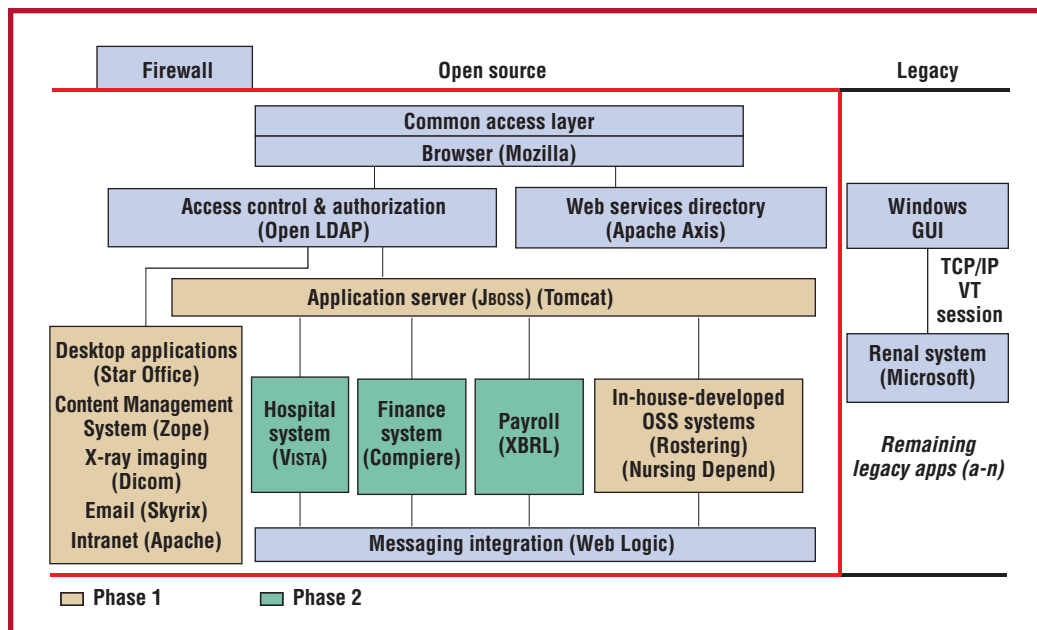


Figure 1. Beaumont Hospital's proposed information systems infrastructure.

these components will continue to coexist alongside proprietary solutions where the latter offer greater functionality or where they're easier for the hospital's IT department to operate and fulfill requirements satisfactorily. The green-shaded areas in Figure 1 indicate the planned OSS enterprise systems for Phase 2.

Phase 1

The prospect of an enterprise-wide Linux conversion was daunting. The hospital decided to break up this task into more manageable phases. The first phase, after the initial proof of concept, focused on the desktop and desktop-productivity tools. The second phase has focused on application-support solutions. However, although this is a neat way to characterize the situation from an abstract or managerial perspective, the reality is more messy. Elements of the enterprise solutions—for example, rostering—had actually predated some work on the desktop productivity option set. In general, however, Phase 1 is more accomplishable than Phase 2 because of the risks, organizational impact, and scale of effort involved.

We expect to have a Phase 1 process—that is, an entirely Linux-based desktop environment—implemented by the end of the second quarter in 2004. Progress on Phase 2 is still at a relatively early point, and it's difficult to predict when it will be complete. However, there are some organizational imperatives that demand that at least core aspects of the

current infrastructure be in place due to the retirement of an existing mainframe system in December 2006. To a degree, that bounds the Phase 2 process.

The work in Phase 1 largely relies on selecting and implementing generic products, such as desktop applications, email, and a content management system.

Desktop applications

Beaumont has deployed the Star Office desktop suite but initially found the deployment problematic for users and the technical staff. Beaumont's IT policy is to follow a thin-client strategy whereby applications are downloaded from the network where practical. The initial implementation was Star Office 5.2, which loaded onto a single Linux server. However, the server became overwhelmed and was then clustered to sustain a dual-server strategy. Despite this, users continued to unpredictably lose network connections. This inevitably increased frustration and tension among the entire work force who were dependent on these tools. A lot of the problems were resolved a few months later with the implementation of Star Office 6, which we installed on the desktop instead.

One of the unexpected benefits has been Star Office's ability to exploit its built-in XML capabilities, which let users structure documents so that sections of the documents can incorporate processing logic—for example,

Until relatively recently, most hospitals printed x-ray images on film for viewing on light-boxes (analog mode). Now most x-ray modalities generate digital images.

creating an online human resources form request that is then automatically routed to the HR department for processing. This provides significant additional functionality over what was previously offered in Beaumont's proprietary desktop applications.

Interestingly, some users—who either already had current alternative products or the money to purchase them—opted not to install Star Office. Approximately 80 users (approximately 8 percent) of the installed base made this choice. However, Beaumont's IT manager informed these staff that they must assume responsibility for upgrading the hardware they use, providing resources for future maintenance upgrades, and so forth.

Content management system

Beaumont's content management system (CMS) is based on Digital Creation's Zope. The product is downloadable for free, but the implementation in Beaumont cost €20,000 in terms of support from a small local software company, OpenApp, that specializes in brokering OSS solutions. Beaumont's CMS provides information such as HR policies, laboratory standard operating procedures, personnel and nursing online forms, minutes of working-group meetings, and multidisciplinary patient care documents. The Zope application server lets the IT department automatically manage these documents by using the metatags associated with each document type, which implement rules about how to display information, who is authorized to see it, who can change it, and so on. The IT staff supplemented this approach by closely integrating it with Beaumont's LDAP server, which holds details on every employee. Overall, the experience has been positive, and CMS use is growing.

X-ray imaging

Until relatively recently, most hospitals printed x-ray images on film for viewing on light-boxes (analog mode). Now most x-ray modalities generate digital images. The international standard *Digital Imaging and Communications in Medicine* has defined a standard way for creating and storing such images. At Beaumont, Sun Microsystems donated a Sun Fire V880 with 1 Tbyte of disk storage for these images. Beaumont's IT staff then developed a solution to let the medical staff retrieve and view the digital images on-

line. This involved writing Perl scripts to extract a DICOM work list from the existing HP-3000-based radiology information system.

Another hospital in Ireland with an equivalent number of beds spent approximately €4.3 million to implement a commercial *picture archive and communications system*. (PACS commonly refers to the subsystems for displaying, diagnosing, and reporting on digital images in hospitals.) Beaumont will need to spend an estimated €250,000 to upgrade its network's quality to sustain rapid data retrieval. It will also need to purchase additional high-resolution workstations to ensure that the radiologists can make safe, consistent clinical diagnoses. It's likely to spend approximately €400,000 on these items. However, Beaumont already spends approximately €480,000 for x-ray film annually. So, the hospital should be able to generate funding for this additional investment through internal savings.

Email

Like many large organizations, Beaumont uses email for internal and external communications, holding an 800-user license for Lotus Domino. There was an organizational demand to expand email coverage to all 3,000 staff, but the cost of this exceeded the tight budget available. The IT staff searched for an alternative email solution and eventually selected the open source Skyrix email package (www.skyrix.com). It provides all the basic email functions that users require, and more important, it provides email access to all 3,000 staff in the organization, a feature that Beaumont's various administrative functions greatly appreciate.

Phase 2

We can characterize Phase 2 as when the OSS rubber meets the enterprise road. As we mentioned earlier, the work in Phase 1 largely relies on selecting and implementing generic products. However, the hospital's requirements as an enterprise means we must address the classic issues of software and organizational adaptation, integration, conversion, and so on. This involves engaging significant streams of the main hospital's activity. This engagement is bounded by the need to find an alternative solution to existing operational systems, which we will cease to support by December 2006.

Table 1**Costs for open source systems versus comparable closed-source solutions for Phase I**

Application	OSS solution		Closed-source software solution	
	Initial cost (€)	Total cost over five years (€)	Initial cost (€)	Total cost over five years (€)
Desktop applications	27,500 (StarOffice)	34,700	120,000	288,500
Content management	20,000 (Zope)	32,100	126,000	140,200
Digital imaging (x-ray)	150,000	237,000	4,300,000	7,340,000
Application server	10,000 (JBoss)	60,500	302,000	595,300
Email	1,000 (SuSE Email)	8,700	110,000	175,000
Total	208,500	373,000	4,960,000	8,540,000

Vista hospital system

In terms of an overall hospital information system, Beaumont is investigating the open source VISTA (Veterans Health Information Systems and Technology Architecture, www.va.gov/vista_monograph). VISTA is a richly functional integrated solution developed by the Veterans Administration of the US Department of Defense over the past 20 years. It has been thoroughly field-tested over 25 years in the US. It is also used in Germany, Finland, and Nigeria. It's supported by an enthusiastic and active community of users (www.hardhats.org), who provide support to all the application's users.

Compiere financial system

Beaumont has also positively evaluated Compiere (www.compiere.org), a fully functional open source financial management system that appears to offer the same (or richer) degree of functionality as the current proprietary applications in place. The application is written in Java and runs on Oracle or PostgreSQL. The developers made it available as open source because they recognized that the marketing investment necessary to go head-to-head against the more established financial solutions was so significant that it diverted their efforts from service and product development.

Payroll system

Beaumont has developed several internal systems that it's offering to others as open source software. One of these systems concerns staff rostering, which supports the

process of creating nursing, medical, and other rosters. This area is characterized by a great variation in rules and work practices as well as the necessity to ensure that the requisite skills, from a medical and nursing point of view, are available on each shift.

An interesting aspect of this latter development is that the system incorporates rules-based logic—using the Extensible Business Rules Language (XBRL) to express it as a set of business rules. Beaumont intends to expand this development to incorporate a payroll capability in the rostering system and to develop a full payroll system in XBRL, thus saving the €95,000 annual fee being paid to a vendor for this service. This is especially interesting because developing in-house payroll systems is virtually unheard of in Irish organizations today.

Reasons for moving to OSS

Researchers have given much attention to the motivation of individual OSS developers but haven't focused much on the motivations of organizations deploying OSS. Beaumont's motivations fell into two categories: principle and pragmatism.

Principle

Beaumont's primary desire was to get the best possible return for the taxpayers' money. As Table 1 shows, the initial savings of OSS over closed-source alternatives for Phase 1 were approximately €4.7 million. When viewed over a five-year period, the savings amount to approximately €8.2 million. Beaumont Hospital

Table 2**Estimated costs for OSS versus comparable closed solutions for Phase 2**

Application	OSS solution		Closed-source software solution	
	Initial cost (€)	Total cost over five years (€)	Initial cost (€)	Total cost over five years (€)
VISTA (for 1,000 concurrent users)	1,700,000*	2,500,000	7,400,000**	12,400,000
Compiere	10,000*	60,000	761,000	1,500,000
Integrated payroll	75,000	97,500	95,000	475,000
Total	1,800,000	2,700,000	8,300,000	14,300,000

* The costs for VISTA and Compiere assume the use of proprietary databases. If the hospital used OSS databases, the savings would be even greater.

** These costs were quoted to another organization and have been adjusted so as to apply to Beaumont.

uses academic discounts for most of these components; thus, the costs for a typical commercial organization implementing such proprietary packages would be even higher.

Table 2 shows the estimated initial cost and the cost savings that will accrue over a five-year period from the deployment of the Phase 2 OSS enterprise solutions. Again, the initial savings of almost €6.5 million and the ongoing savings over a five-year period of almost €12 million are significant.

Calculating the total cost of ownership of software acquisition is complex. To do so, we must consider several areas, including software purchase, maintenance and upgrade costs, hardware purchase and maintenance costs, and administrative costs. In Beaumont, we chose to focus in depth on software purchase as well as maintenance and upgrade costs, and we calculated these total costs over a five-year period. In these calculations, we made every effort to compare like with like, in that the estimate of the comparable costs is based on prior experience in Beaumont or on two alternative estimates.

Pragmatism

Given the contraction in Beaumont's IT budget, the hospital was faced with either reducing its overall level of service to cope with these restrictions or finding cheaper alternatives. Beaumont's IT staff already had experience with Unix applications, so the transition wasn't as radical as it would have been if the operation experience was based on GUI-enabled systems administration.

The ideology of free access to source code wasn't really a factor in Beaumont's decision to deploy OSS solutions. The IT manager admits that OSS in the Beaumont case amounts

to "zero cost or as cheap as possible." Indeed, this is evident in the choice of Star Office rather than the free open source equivalent Open Office IT management's decision to purchase Star Office was based on the availability of support directly from Sun.

Lessons learned

Beaumont perceived an element of risk in deploying OSS-based solutions. Open source systems lack the comfort zone that a commercially acquired solution provides; rather, support comes from bulletin boards and the like. So, top management support is critical. However, given that there are no slick marketing campaigns for OSS, Beaumont's users have become involved in identifying and acquiring OSS solutions. It's become a unifying process organizationally, blurring the traditional lines between internal IT staff and users.

Also, because OSS is more or less free, there's often the misperception that service and support should also be correspondingly priced, which is a difficult mindset to break. Although the OSS phenomenon is sometimes characterized as a threat that will stifle the local software development industry, agile small to medium-sized enterprises anywhere in the world can leverage the innovative OSS model as an infrastructure on which to create new business opportunities.

The "free rider" issue, whereby individuals or organizations merely receive all the benefits of the OSS development work of others and never contribute anything themselves, has also been identified as a major problem for OSS. Although Beaumont isn't likely to contribute to the Linux kernel's code base, for example, they are keen on contributing to the OSS community. They've made several applications

they developed (a staff rostering system, a tissue-matching system, and a casualty system) available as OSS, which bodes well for the future of OSS.

A great deal of research has been conducted on the OSS phenomenon across a range of disciplines, but it has mainly focused inward on the OSS phenomenon—for example, identifying the characteristics of OSS projects and the motivations of developers. Few studies such as this exist that focus outward on the OSS consumers and the manner in which we can codeploy OSS and proprietary software in an overall IS infrastructure.

Although Beaumont is satisfied with its OSS implementation overall, they have experienced problems, which other organizations contemplating OSS implementation would probably also face. There was a resistance from staff who feared being deskilled by losing experience with popular commercial software packages. Also, Beaumont is a little worried that its operations staff, who have amassed considerable experience in OSS deployment, might now be poached by other organizations.

The importance of changing the mindset in relation to the new support paradigm implied by OSS is also significant. By and large, reliance on a standard maintenance contract isn't an option, and bulletin boards might be the main source of support. Thus, it is hardly surprising that support from top management is critical. Also, even though OSS may be available at little or no cost, organizations should not expect maintenance and support to be available at a lesser cost than would apply for commercial software. Indeed, OSS represents a good opportunity for small software companies all around the world to treat it as an infrastructure component, like the highway or telecommunications lines, and then use it as a bootstrap to build a service and support business model on top. ☛

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