

OpenOffice.org: When Will It Be Ready for Prime Time?

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ABSTRACT

Although debatable, free/open source software (F/OSS) is often less expensive, yet nearly as capable as proprietary applications software. In spite of this, proprietary software is overwhelmingly the typical option chosen by most organizations. The question is “Why is F/OSS not more widely in use, and under what circumstances might F/OSS represent a better solution to an organization's computing needs?” This research investigates the feasibility of adopting commercial F/OSS for desktop applications, in particular, office productivity applications such as OpenOffice.org and operating systems such as Linux. Benefits and shortcomings of F/OSS are addressed, and barriers to the adoption of F/OSS alternatives are discussed.

INTRODUCTION

Proprietary software is the typical choice of large organizations for a wide variety of applications and has in numerous cases become the standard. This has occurred in spite of the fact that commercial open source alternatives, almost always less expensive (and generally free) initially, exist for most common software applications packages. For example, it is essentially expected that organizations will be using the Microsoft (MS) Office suite to meet their productivity software needs: spreadsheets, word processing, presentations, and small data management tasks. Similarly, one version or another of MS Windows is generally considered the standard desktop operating system for the non-Apple world. Certainly the Microsoft and other proprietary products, such as those from Oracle, Blackboard, and SAP, are good and cost-effective solutions for most applications that truly warrant market leadership. However, free/open source software (F/OSS) provides good (and often very close) second-best alternatives, and it is therefore curious that they do not enjoy better market share. It is the purpose of this paper to address this apparent anomaly.

One of the more visible F/OSS products is OpenOffice.org, a desktop applications package that provides office productivity tools. Essentially OpenOffice.org (currently owned by Sun Microsystems) serves as an alternative to MS Office. (Note that, while often referred to simply as “OpenOffice”, that name is a trademark held by another firm.) Although continually improving and nearly as functional as MS Office yet available at no charge, OpenOffice.org has seen relatively little acceptance. In addition, a number of firms (e.g., Red Hat, Novell, and Ubuntu) make distributions of the Linux operating system (OS), another example of F/OSS, available at essentially no charge. Linux has enjoyed reasonably strong success as a server OS, but comparatively few organizations or individuals have chosen Linux for their desktop computers. Similar F/OSS technical successes accompany the lack of market success to date with other products, both on the desktop and in the back-office. Those will be addressed, but the

focus of this paper is on OpenOffice.org versus MS Office, since that battle is somewhat iconic to the larger realm of F/OSS versus proprietary software in general.

OPEN SOURCE BACKGROUND

The term *open source* has been used in varying ways to describe software. Strictly speaking, open source refers to access to an application's source code and the freedom to modify that code, although relatively few users are concerned with this freedom. In fact, a number of firms that distribute open source software commercially have restrictions in their licenses and prohibit certain modifications to the source code. This research is concerned more specifically with what is generally known as free/open source software (F/OSS). Coined by in Terry Bollinger in a MITRE Corporation report (Bollinger, 2002), F/OSS is also referred to as FLOSS (free/libre open source software), to clarify that “free” does not necessarily mean “no charge” but more generally implies freedom. As discussed in *Wikipedia*,

“F/OSS' is an inclusive term generally synonymous with both free software and open source software which describe similar development models, but with differing cultures and philosophies. 'Free software' focuses on the philosophical freedoms it gives to users and 'open source' focuses on the perceived strengths of its peer-to-peer development model.” (“Free . . .”, 2008)

In particular, this paper addresses *commercial* F/OSS applications, meaning software that is developed/distributed for profit. While revenues for such software generally are not derived by the sale of the software, the services (e.g., support, configuration, etc.) and the add-ons associated with the distribution of the software support the firms involved (Cohen, 2008; Zymaris, 2005).

Open Source Literature

While considerable attention has been given in the popular press (in particular, trade journals) over the past ten years to open source software, relatively few articles appear in academic journals and similar outlets. Quantitative modelling of participation in open source development and adoption appears essentially to be the focus in both business and computer science journals, as evidenced, for example, by Lee et al (2009). They develop a model for open source software success and identify determinants of success, finding that software and community service quality both have significantly positive effects on user satisfaction, which in turn affects individual net benefits. In an earlier and related paper, Meng & Lee (2005) model competition between open source and proprietary software providers. They found that, depending upon market conditions, compatibility can be beneficial for all parties and that social welfare may be lowered when proprietary rivals adopt the open source model.

Lerner & Tirole (2003) developed an exploratory study that addresses what economists consider the “startling” behavior of numerous market participants collaborating on open source projects. They conclude by providing a number of research questions to be addressed by future researchers. In an earlier paper focusing in particular on Linux, Godfrey & Tu (2000) proposed that, because the Linux kernel is quite large, Linux would grow more slowly as it became larger. However, results of the research showed that Linux had grown at a super linear rate during

recent years. Nichols & Twidale (2002), noting the use of proprietary software by most users, addressed how characteristics of open source software can influence the usability of that software. In a masters thesis, Schearer (2008) noted the considerable expenditure annually by the Department of Defense (DoD) on desktop software, both for OS and for office productivity applications. The paper examines the opportunities for using F/OSS instead and addresses regulations and policies that may or may not inhibit such usage.

As indicated above, most of the remainder of the literature associated with F/OSS is of a less formal nature, consisting of trade journals, blogs, and some business publications. Nevertheless, for the purposes of this paper – addressing the feasibility of broader adoption of F/OSS desktop applications – that body of literature is actually more appropriate. Major issues and findings from that literature are therefore addressed herein and have been used to frame this study.

Categories of Operations Supported

Open source literature treatment of F/OSS suitability and deployment tends to group applications into the categories proposed by the UK's Office of Government Commerce (OGC), as summarized above: infrastructure products, business applications, and desktop products (OGC, 2004). Infrastructure products are generally based on the Linux OS and include servers and other appliances, performing web, database, network, and similar support tasks. Whereas the adoption of desktop and business application F/OSS has been minimal to date, certain F/OSS infrastructure products have been quite successful. It is interesting to note, for example, that over 50% of all Internet servers run the F/OSS Apache web server, while the proprietary MS web server Internet Information Services (IIS) has around 30% of the market (“December . . .”, 2008). Numerous success stories attest to the improvement of cost structures based upon adoption of the Linux OS (Hoffman, 2008; Sliwa, 2003; Surran, 2003; Walters, 2007), and security is also considered by many to be better (Kraft, 2008; OGC, 2004).

Business applications refers to large-scale projects and includes enterprise resource planning (ERP), data mining / business intelligence (to include customer relationship management), web content management systems, course management systems, and the like. At the time of the OGC report, business applications were considered to be in their infancy and generally not ready for wide scale adoption. It was concluded that, while small and medium sized business (SMBs) might benefit from F/OSS business applications, such software was yet not sufficiently “industrial strength” for large enterprises or public sector bodies. Furthermore, the cost and complexity of switching to F/OSS from proprietary software can be prohibitive (Cross, 2004; OGC, 2004). Considerable maturity has however occurred in the past several years, and increasingly more stories of successful implementation of F/OSS business applications are being told. Babcock (2008), reports on how a number of commercial products, including the enterprise integration solution Jitterbit, are starting to deliver consistently code that is not only less expensive but also more reliable. Some promising F/OSS solutions for business intelligence applications include Pentabo, Talend, and Jaspersoft and are now being used by large organizations, such as the University of North Carolina (Byrd, 2008). BlueStar Energy, a broker supplying electricity to customers in Illinois, Maryland, and the District of Columbia, recently developed its own ERP system from a number of F/OSS components (Hoffman, 2008). Noting that, although up front expenditures can be similar for F/OSS and proprietary software, the TCO

beyond the first year is substantially less for F/OSS course management systems such as Sakai and Moodle, ERP systems like Quali, and web portal software such as uPortal (Moore, 2008; Panettieri, 2008).

Likely the most well known F/OSS desktop application, OpenOffice.org is a rival to MS Office and includes spreadsheet, word processing, presentation, and database applications for use in desktop computing. In addition, a number of other commercial products are available for meeting various end-user needs. These F/OSS tools include products such as Rational Application Developer (a software development tool), OpenWorkbench (for project management), R Evolution R (for statistical analysis package), and the reasonably well known Firefox web browser from Mozilla (“Commercial . . .”, 2008). These products are often considered to have less functionality than their proprietary counterparts (Babcock, 2008). For example, OpenOffice.org was criticized by a Microsoft spokesman in 2003 for having roughly the same feature set as the 1997 version of Office (Vaughan-Nichols, 2003). In contrast, many end-users feel that OpenOffice.org and other F/OSS offerings nevertheless have plenty of features and that many of the features offered by proprietary software go unused (Vaughan-Nichols, 2003). While support for the adoption of F/OSS desktop solutions (in particular, Linux) has come from a number of directions (Kraft, 2008; Roberts, 2004; Sliwa, 2003), there has nevertheless also been some notable opposition. In spite of predictions by the Linux community that desktops would soon see a substantial increase in Linux, it is notable that a 2004 survey conducted by ComputerWeekly.com, revealed that only five percent of Windows users polled said they planned to switch to Linux on their desktops (“Study . . .”, 2004). An article in *Silicon.com*, an online IT industry publication, reported that Barclays Bank has refused to consider adopting Linux or other open source solutions, stating that ultimately there are no overall cost savings (McCue, 2003). Interestingly, responses to the article were overwhelmingly critical, stating in many cases that the Barclays official interviewed was out of touch.

The Nature of Open Source Software

Common among licenses for F/OSS is the *copyleft* concept, whereby running, copying, modifying, and distributing are all permitted, provided no further restrictions are added. In addition, selling modified versions for profit is also permitted (Barr, 2005). The general intent is to treat software as community efforts in order to expand the possibility for intellectual contributions that can improve that software. As stated by Eric Raymond, author of *The Cathedral and the Bazaar*, “Given enough eyeballs, all bugs are shallow” (Raymond, 2001).

Since all code in open source projects is available and anyone is encouraged to contribute, one of the recognized benefits of such projects is the collaboration that takes place. Participating in open source development projects has been likened to “going in with others on a pizza” (Cohen, 2008). That is, just as a single pizza might be more than any one person might desire to eat (and pay for), a software development project might not be cost effective for a single organization. However, joining development efforts with others can bring the cost per organization down to an acceptable level and all organizations will then benefit from software none would have been able to develop individually. The cost is shared, and the software is developed to meet the needs of the organizations involved. As summarized by Farber (2004), F/OSS development is “more democratic than proprietary software and the debates are public. While many, if not most, F/OSS

products involve a zero cost for licensing, just as with proprietary software, the TCO for F/OSS must consider implementation, training, integration, and support costs. For example, Novell's SUSE Linux Enterprise Server (SLES) is a complete enterprise-grade OS and can be downloaded, installed, and used by any organization without charge ("SUSE . . .", 2008). No particular expertise is involved to install, configure, and run the software, and there is no expiration on that license. However, support, such as automated driver updates and security patches, technical advice, etc. beyond the initial 60 day trial period, require the payment of an annually renewable licensing fee. The same applies for the SUSE Linux Enterprise Desktop (SLED) OS. As summarized in a report by the Yankee Group, organizations have generally begun to realize that Linux is not truly free ("Study . . .", 2004).

OpenOffice.org

Currently in the third incarnation (version 3.0) since its inception in 2000, OpenOffice.org is "owned" and distributed by Sun Microsystems. In addition to the standard office productivity tools (spreadsheet, word processing, presentation, and database) other applications included are a graphics editing program and a formula editor. As with MS Office, all of these products together serve as an integrated package, but, in contrast, no email client is included in OpenOffice.org. The native file format is the ISO/IEC standard OpenDocument Format (ODF), but the MS Office proprietary formats not including the current one are also supported. (The ODF, as well as the current Office 2007 file format, is an XML-based format; renaming an ODF file with a compressed file format such as .zip and then running an extraction program will result in a set of XML files.) Along with the various Linux operating systems, MS Windows and Mac OS X, are supported by OpenOffice.org.

Besides OpenOffice.org itself, two other commercial packages have been developed from the OpenOffice.org source. Sun offers a proprietary version, StarOffice (or, in east Asia, StarSuite, with support for Asian languages and character sets). Documentation, training, additional language support, and extra features, such as a macro converter, come with the licensing fee associated with StarOffice. Similarly, IBM offers Lotus Symphony, which can be downloaded and run without charge (Lai, 2007). Because of the open source nature of these three products and the fact that they are all part of the same development project, they are referred to herein as OpenOffice.org.

Both the current and previous version of OpenOffice.org have been capable of saving files as PDF (portable document format) files, and the current version includes some limited capability for editing PDF files. The spreadsheet program, Calc, previously did not include an optimization utility, but the current version, released in late 2008 does. The Solver utility in Calc works essentially like that in Excel, which has for over a decade included this feature as an add-in. Microsoft, with its Office 2007 release, did a nearly total makeover of the interface for its packages by replacing the menu bar with what Microsoft refers to as "ribbons". In contrast, the OpenOffice.org interface retains the familiar look of the menu bar, possibly in response to complaints by advanced users of Office 2007 about not being able to find frequently used features. (Microsoft justified the new interface by stating that it is more efficient and supports the way users actually work with the software; MS admits that novice users should be particularly happy with the ribbon approach, whereas advanced users would likely encounter

difficulties in the changeover.) As indicated above, OpenOffice.org tends to lag behind MS Office in incorporating new features, some of which may be useful although generally not essential. For example, whereas MS Word 2007 has a “change case” feature that facilitates several different conversions, including changing to title case, OpenOffice.org Writer includes only two: upper case to lower, and vice versa. Similarly, MS PowerPoint has for the past two versions enabled shrinking/enlarging selected blocks of content proportionately, yet OpenOffice.org Impress can do this only in an absolute manner, forcing all text to be the same selected size. Calc and Base, the OpenOffice.org equivalents to MS Excel and MS Access, likewise are slightly less feature-rich, as some of the less familiar functions included in Excel are missing from Calc and similar limitations apply to Base. The macro editing process is different in OpenOffice.org, to include a variation of VBA (the language used for coding macro procedures) that incorporates a somewhat different set of objects, methods, and properties. (StarOffice, Sun's proprietary version of OpenOffice.org, does however include a conversion feature that facilitates using MS Office macros). While these features in MS Office are convenient, they are not necessary for most users, although further research is called for regarding what proportion of current users would find those features necessary. For a more complete discussion of OpenOffice.org 3.0, see the article by Brooks (2008) who also provides a number of comparisons with MS Office 2007.

As organizations look to ways to reduce IT expenditures without cutting back on functionality, OpenOffice.org is gaining in popularity. A number of school districts and government offices have recently been turning to OpenOffice.org as a way to cut costs (Klein, 2008; Messina, 2008; Moore, 2008; Nagel, 2007; Surran, 2003; Walters, 2007). Nevertheless, as of 2007, the various versions of MS Office still held approximately 90% of the market (Lai, 2007).

THE CASE FOR DESKTOP F/OSS ADOPTION

As indicated above, OpenOffice.org is quite capable and has a seemingly low TCO, but the market has not responded accordingly. Whereas IT leaders may feel it is a case of “you get what you pay for”, more rational reasons exist for the hesitance of both SMBs and large organizations to adopt OpenOffice.org and other F/OSS solutions. What might be called the “Microsoft inertia” (or habit) may have something also to do with that hesitance. That is, people are accustomed to the MS products, and it will take something significant to move users away from that anchorage. Users, if they have the means, are furthermore in the habit of looking for and acquiring the newest release or version of software, whether there is a need for an upgrade or not. This is essentially the same mentality that drives the annual model changes in automobiles. Deterrents such as these are addressed below, followed by a discussion of reasons for considering the adoption of OpenOffice.org and similar F/OSS desktop products.

Barriers to Adoption

Farber (2004) summarized the major concerns that serve as impediments to the adoption of F/OSS as: the lack of formal support; the velocity of change; no roadmap for future development; functional gaps; licensing caveats; and endorsements from noncredible vendors. While these are somewhat dated concerns, they nevertheless tend to persist. From about the same period of time, the OGC (2004) report adds the following: uncertainty about what

constitutes F/OSS; lack of traditional advertising to help identify suitable products; inadequacy of documentation; and lag in support for new hardware. More recently, Nagel (2007) has echoed concerns about support and has noted also that security is a concern, while integration of F/OSS with pre-existing systems also poses a challenge.

Documentation, support, and endorsements are related issues. Since OpenOffice.org and other F/OSS are far less common than their proprietary counterparts, there is less of an experience base to support F/OSS. IT staff members are thus less likely to be able assist end-users and often will need to be more technically competent, since F/OSS tends to be more Spartan and less intuitive. Consequently, IT support groups may resist migration to F/OSS. Documentation for F/OSS is generally in the form of help screens and downloadable articles rather than as hardcopy supplied by the distributors. Hardcopy is nevertheless available through book stores and the like but is not as easily located as that for proprietary software. This poses major challenges to educators, as textbooks are essentially nonexistent. For example, a December 2008 search of websites for three major publishers – Course Technology (a Thomson imprint), Pearson Education, and McGraw-Hill – produced a total of only three textbooks supporting OpenOffice.org. Documentation is nevertheless available, as evidenced by a similar search of the Amazon.com website. Although that search yielded 50 hits, those books are generally designed as self-help resources rather than textbooks, so there is a greater burden on the instructor when incorporating these materials for classes. Textbook support for Linux is considerably better but nowhere near as good as for any of the Windows desktop OSs. A well-developed textbook for supporting basic Linux instruction, primarily based on Novell's SLES, is part of a series offered by Course Technology and has currently been available for three years, but the SLES version supported (SLES 9) was superseded by a newer version two years ago. Although this is not an insurmountable problem it nevertheless challenges the instructor.

Benefits of OpenOffice.org

What likely gets attention initially about F/OSS for desktop solutions is the lack of licensing fees. Although that alone should not be sufficient for adopting OpenOffice.org, zero purchase costs go a long way toward making TCO, ROI, and other cost analyses favorable, especially at the time of this writing, as a recession is shrinking IT budgets (Moore, 2008). Furthermore, such licensing makes it easy to adopt software on a trial or pilot basis. A number of other benefits of F/OSS have been identified. Surran (2003) listed the following that apply to open source products in general: freedom in implementation and distribution, and consequently from risk of software audits; better quality and stability resulting from collaborative development and open peer review; cross-platform availability; and growing global acceptance. Supplier independence, as well as rapid discovery of vulnerabilities and subsequent distribution of patches, were additional benefits identified by the OGC (2004) report and apply to solutions such as OpenOffice.org. (It is notable that one of the conclusions of the OGC report is that proprietary software prices could be affected by the price pressure brought by greater use of F/OSS products.) Associated with the freedom of implementation is avoiding vendor lock-in is a theme echoed in various ways by those who have adopted F/OSS (Kraft, 2008; Moore, 2008).

Large public organizations, such as colleges, school districts, and government agencies, are concerned about being controlled by a single supplier. Open source products provide cost

effective alternatives, as the State of Indiana has discovered (Klein, 2008; Walters, 2007). Each school is strongly encouraged to provide one-to-one computing for students by supplying low-cost hardware equipped with F/OSS. In a similar action, the State of Massachusetts has mandated that its agencies use open source software unless it can be proven that only proprietary software can accomplish what needs to be done (Roberts, 2004). The flexibility offered by the multi-platform capability of OpenOffice.org helps make these programs and mandates possible, since the choice of Linux as an OS makes no difference but would in contrast rule out the use of MS Office. Linux in turn makes it possible to use less elaborate (and thus less costly) hardware, as the requirements to support MS Windows Vista commonly involve extensive hardware upgrades.

A common perception of F/OSS products is that they require a higher level of technical expertise, both at the end-user level and at the IT support level. However, OpenOffice.org is quite user-friendly, almost to the extent as MS Office is, and installation/support is also roughly equivalent. Similarly, a number of desktop Linux distributions (e.g., SLED and Ubuntu) work through graphical user interfaces (GUIs) similar (and sometimes superior) to MS Windows Vista. Furthermore, with the Linux OS, the user has a choice of which GUI to use, and no particular IT technical expertise is required for IT support, since it is possible for essentially all administration chores to be accomplished through the GUI.

Interestingly additional benefits accrue when Linux is chosen as the desktop OS for schools, whether K-12 or higher education (Surran, 2003). For one thing, businesses looking to hire IT staff are pleased when they find that students have Linux experience. Another is that students tend to receive instruction in and experience with fundamental concepts, rather than specific products. When those students need to apply what they learn on the job, they will be more ready to adapt to the “next Microsoft” (or VisiCalc, WordPerfect, or whatever).

CONCLUDING REMARKS AND FUTURE WORK

Rather than addressing when OpenOffice.org (and similar desktop F/OSS) will be “ready for prime time”, we should ask “When will prime time be ready for OpenOffice.org”. That is, a number of valid reasons exist for adopting F/OSS, and barriers to doing so may or may not be sufficient to block the *adoption* of F/OSS but not its *consideration*. This can essentially be represented as a multicriteria decision problem, with criteria represented by the benefits and barriers and a single decision variable, desktop applications platform. Each organization should therefore determine its priorities and evaluate how OpenOffice.org will meet those priorities. Likely many organizations will realize their “prime time” will be quite suited to F/OSS.

This research represents an initial investigation into the viability of F/OSS in general. Certainly, organizational characteristics will determine what choices should be made for desktop applications platforms, and further research is warranted. A survey is being developed to determine organizational traits, existing desktop platforms, attitudes toward F/OSS, current expenditures for desktop software, etc. Based upon the analysis of the survey, two products are planned: general guidelines for the adoption of OpenOffice.org and/or other F/OSS, and a multicriteria decision model to support the selection of F/OSS.

REFERENCES

- Babcock, C. (2008). The open source enterprise. *Information Week* (1211), 41-47.
- Barr, M. (2005). Open source versus proprietary software: a discussion. *matthewbarr.co.uk*.
<http://www.matthewbarr.co.uk/opensource.htm> (10/31/2008).
- Bollinger, T. (2002). Use of free and open source software (FOSS) in the US Department of Defense (Report number MP 02 W0000101). McClean, VA: The MITRE Corporation.
http://terrybollinger.com/dodfoss/dodfoss_html (12/31/2008).
- Brooks, J. (2008). OpenOffice at 3.0. *eWeek* (10/2/2008), 36-38.
- Byrd, R. (2008). The argument for open. *Campus Technology* 22(3). 39-46.
- Cohen, S. (2008). Open source: the model is broken. *Business Week* (12/1/2008).
http://www.businessweek.com/technology/content/nov2008/tc20081130_276152.htm (12/31/2008).
- Commercial open source applications (2008). In *Wikipedia, The Free Encyclopedia* (12/16/2008).
http://en.wikipedia.org/w/index.php?title=Commercial_open_source_applications&oldid=258428970 (12/31/2008).
- Cross, M. (2004). Open invitation taken up at last. (12/2/2004). *guardian.co.uk*.
<http://www.guardian.co.uk/society/2004/dec/01/eublic.technology7> (12/31/2008).
- Dalle, J., & N. Jullien (2002). Open-source vs. proprietary software. Working paper.
<http://opensource.mit.edu/papers/dalle2.pdf> (12/31/2008).
- December 2008 web server survey (2008). At *NetCraft.com* (12/31/2008).
http://news.netcraft.com/archives/web_server_survey.html (12/31/2008).
- Farber, D. (2004). Six barriers to open source adoption. *ZDNet* (3/20/2004).
http://techupdate.zdnet.com/techupdate/stories/main/Six_barriers_to_open_source_adoption.html (12/31/2008).
- Free and open source software (2008). In *Wikipedia, The Free Encyclopedia* (12/26/2008).
http://en.wikipedia.org/w/index.php?title=Free_and_open_source_software&oldid=260145574 (12/31/2008).
- Godfrey, M., & Q. Tu (2000). Evolution in open source software: a case study. *Software Maintenance 2000 International Conference Proceedings*, 131-142.
<http://www.st.cs.uni-saarland.de/edu/empirical-se/2006/PDFs/godfrey00.pdf> (12/31/2008).
- Hoffman, T. (2008). Energized by open source. *Computerworld* (12/10/2008). 30-34.
- Kraft, W. (2008). OSBC attendees bullish on open source. *Campus Technology* (3/31/2008).
<http://campustechnology.com/Articles/2008/03/OSBC-Attendees-Bullish-on-Open-Source.aspx> (12/31/2008).
- Klein, J. (2008). Implementation study #2: Indiana desktop Linux. (1/8/2008). CoSN K-12 Open Technologies Leadership Initiative. <http://k12opentech.org/implementation-study-2-indiana-desktop-linux> (12/31/2008).

- Lai, E. (2007). IBM composes new Office rival with Lotus Symphony suite. *ComputerWorld* (9/18/2007).
<http://www.computerworld.com/action/article.do?command=viewArticleBasic&articleId=9037358>
 (12/31/2008).
- Lee, S, H. Kim, & S. Gupta (2009). Measuring open source software success. *Omega* 37(2), 426-438.
- Lerner, J., & J. Tirole (2003). Some simple economics of open source. *The Journal of Industrial Economics* 50(2). 197-234.
- McCue, A. (2003). Desktop Linux – no cost savings, says Barclays CTO. *silicon.com* (12/19/2003).
<http://hardware.silicon.com/desktops/0,39024837,39117438,00.htm> (12/31/2008).
- Meng, Z., & S. Lee (2005) Open source vs. proprietary software: competition and compatibility. SSRN Working Paper Series (August 2005). <http://ssrn.com/abstract=780804> (12/31/2008).
- Messina, I. (2008). Konop: \$4M cut could pay for college plan: commissioner urges 4-day county work week. *McClatchy - Tribune Business News* (12/16/2008).
- Moore, J. (2008). It's 'open' season. *Campus Technology* (2/1/2008).
<http://campustechnology.com/articles/2008/02/its-open-season.aspx> (12/31/2008).
- Nagel, D. (2007). Open-source schools: got data? *T.H.E. Journal* (1/29/2007).
<http://www.thejournal.com/articles/20027> (12/31/2008).
- Nichols, D., & M. Twidale (2002). Usability and open source software. Working paper (12/2002).
<http://opensource.mit.edu/papers/nicholstwidale1.pdf> (12/31/2008).
- Office of Government Commerce (2004). Open source software trials in government (10/21/2004).
<http://www.ogc.gov.uk/documents/CP0041OpenSourceSoftwareTrialReport.pdf> (12/31/2008).
- Palamida finds security tops list of concerns inhibiting broader open source adoption (2008). *Business Wire* (12/16/2008).
- Panettieri, J. (2008). Is open source the ERP cure-all? *Campus Technology* 21(9). 30-35.
- Raymond, E. (2001). *The Cathedral & the Bazaar*. Sebastapol, CA: O'Reilly.
- Roberts, B. (2004). Desktop wars, the sequel. *Electronic Business* (2/1/2004).
<http://www.highbeam.com/doc/1G1-113342682.html> (12/31/2008).
- Schearer, S. (2008). Increasing Open Source Software Integration on the Department of Defense Unclassified Desktop. Naval Postgraduate School masters thesis (6/1/2008).
<http://www.stormingmedia.us/52/5263/A526384.html> (12/31/2008).
- Sliwa, C. (2003). Sidebar: early adopter stands firm on linux desktop. *Computerworld* (12/15/2003).
<http://www.computerworld.com/softwaretopics/os/linux/story/0,10801,88191,00.html> (12/31/2008).
- Study finds Linux has higher total cost of ownership than Windows (2004). *ComputerWeekly.com* (4/6/2004).
<http://www.computerweekly.com/Articles/ArticlePage.aspx?ArticleID=201515> (12/31/2008).
- Surran, M. (2003). Making the switch to open source software, *T.H.E. Journal* (9/1/2003)
<http://www.thejournal.com/articles/16448> (12/31/2008).
- SUSE Linux Enterprise (2008). At *Novell.com* (12/1/2008). <http://www.novell.com/linux> (12/31/2008).

- Vaughan-Nichols, S. (2003). How much office functionality do we really need, anyway? *eWeek* (10/10/2003), <http://www.eweek.com/index2.php?option=content&task=view&id=31801> (12/31/2008).
- Waters, J. (2007). Opening a new door. *T H E Journal*, 34(8), 30-35.
- Zymaris, C. (2005). How to make money from open source. *Builder AU* (6/2/2005). <http://www.builderau.com.au/strategy/businessmanagement/soa/How-to-make-money-from-Open-source/0,339028271,339191343,00.htm> (12/31/2008).