

Open Source Systems Applications

Christopher Peckham and Miguel Rodriguez

Abstract—Henry Bros. Electronics (HBE) has been deploying a wide variety of open source systems over the last two years. These systems touch every aspect of the business including sales lead tracking, time reporting, and asset management. Open source systems are also used for the company’s internal portal and a client-facing reporting engine. Some of the company’s file servers are deployed using open source software and all of the networks and services are monitored using open source. Backups and PBX services are also provided using open source. The paper will discuss how the company uses open source software in these areas as well as plans to deploy more systems in the future.

I. INTRODUCTION

Henry Bros. Electronics, Inc. (HBE) provides electronic security systems, services, and emergency preparedness consultation to commercial enterprises and government agencies in the United States. It offers design, installation, and support services for various perimeter protection, surveillance and communications control systems, such as access control, intrusion alarms and closed circuit television. The company’s services include consulting and planning, engineering and design, systems installation and management, systems training and maintenance and technical support. HBE also provides emergency preparedness planning services, which include demonstrations, training, and recommendations, to commercial real estate owners and managers. In addition, it designs, manufactures, and maintains wireless communications equipment used to extend emergency radio frequency services and cellular communication for fixed and mobile applications. HBE is headquartered in Fair Lawn, New Jersey with offices covering the metropolitan markets of Phoenix, AZ, Dallas, TX, Denver CO, DC Metro and Southern, CA.

HBE has been improving its IT infrastructure over the past few years. A number of open source packages have been installed and integrated to allow this upgrade to occur while minimizing capital expenditures. These systems provide sales processing, time tracking, asset management, reporting, network monitoring, backups, PBX services, and many other functions.

The paper will introduce open source software and some of the advantages and disadvantages, how HBE uses OSS to provide services, how OSS is used on the desktop, what the company may work towards in the future, and some conclusions.

II. OPEN SOURCE SOFTWARE

Open-source software (OSS) is available in source code form for which the source code and certain other rights

normally reserved for copyright holders are provided under a software license that permits users to study, change, and improve the software [1]. A further definition of open source software is made by the Open Source Initiative [2] where it needs to have: free redistribution, source code must be included, must allow modifications and derived works, integrity of the author’s source code, no discrimination against persons or groups, no discrimination against fields of endeavor, a single license must apply to all users, and the license must be technology-neutral.

There can be advantages and disadvantages in using OSS [3, 4]. A number of these advantages are that the core software is free, major systems are constantly evolving, the base code is secure and peer-reviewed, and it allows for quick innovation. It also encourages a hands-on process, flexible technology, and users are not tied to a single vendor. There are also some disadvantages in using OSS. There can be a learning curve and lack of support for some projects. Projects die due the development team losing interest or team dynamics. Support on many packages can be difficult to obtain. While forums can provide a wide range of support, many questions are not addressed. Package management and version control can be difficult to address as well if systems are not upgraded and managed over time.

The total cost of ownership of OSS is open for interpretation. Open source software is available for free and therefore the acquisition cost is lower than that of proprietary software. Installation, operation, training support costs for OSS can be similar to that of proprietary software. Depending on the package and the knowledge of the staff, it can be higher. The support and maintenance process still need to be performed. Many business may implement OSS but obtain a support contract for critical systems [5, 6].

III. SYSTEM AND SERVER SOFTWARE

HBE has implemented a large number of open source software packages to provide functionality to the business where nothing existed before or there was a need to enhance an existing package or platform. In many cases, these systems would not have been implemented had there been a cost associated with the purchase of the software. In all cases, there was some level of internal support required to implement and integrate the system into the existing environment. Reliability, stability and cost have been the foundation for deploying OSS at HBE. Severe defects have tended to be fixed within hours or days of

being detected. Reduced total cost of ownership with a zero dollar software purchase price and no need to account for copies in use are but a few reasons OSS has been deployed at HBE.

OSS has been used to provide sales lead tracking, time reporting, asset management, portal functionality, a reporting engine, file services, monitoring services, backups, PBX functionality, and a number of internal systems.

A. Sales Lead Tracking

Customer Relationship Management (CRM) is the process of managing relationships with customers and prospects. A CRM system can be viewed as a tool to drive results for a company and will allow the sales force to track leads and opportunities through the entire sales lifecycle. It also serves as the basis for the management of the sales pipeline. The process and the resulting information can assist the sales staff in reaching their goals and quota. The use of a CRM allows the sales force to work in a more focused manner and provide a common information source for sales management.

HBE implemented the open source version of SugarCRM [7]. Sales prospects are tracked in the system as leads, activities, opportunities, and contacts. Reports are then generated showing sales activities and stages from across the company. Additional fields are displayed on a PDF or Excel report that is generated using php. The use of the system has allowed the sale staff to standardize how the sales process is reported to management. It allows management to use the system as the authoritative source of sales stage information.

B. Time Reporting

Human resources management is the process of managing a staff so they can achieve the goals of a business. OrangeHRM [8] is a HR management information system that provides a wide range of features to help manage staff. The system has modules to provide different HRM functions including personnel information management, employee self service, leave requests, and time and attendance reporting. The system is written in php and may be used by any browser. HBE has modified OrangeHRM to allow for a different time entry format as well as storing training certification information.

The system is updated multiple times a day from HBE's accounting system, Sage Timberline Office, to obtain job information for all non-closed jobs. Information from each HBE location is fed into the system and staff at each location may only see information for their clients and jobs. The system also allows users to know who has entered and submitted timesheets at any given time. There are plans to also allow time to be posted against sales opportunities at a certain stage listed in SugarCRM.

C. Asset Management

HBE has implemented two different systems to track assets; A CMMS is used for client systems and a client-server system is used for internal systems.

A Computerized Maintenance Management System (CMMS) maintains a database of information about assets and maintenance operations. The information in the system could be used to determine what assets are scheduled for preventive maintenance, tracking of work order requests and scheduling, what spare parts are required for a service call, and inventory control. This information can also be used to verify regulatory compliance. The use of the system also simplifies the management of the equipment maintenance process.

HBE's CMMS system is CalcmEAM [9]. The system may be used from the WWW and in an offline mode on a laptop or a handheld computer. The technicians enter information into the system for tracking and real time reporting for work tickets and asset management control, allowing better decision making associated with assets. Clients are also provided access to reports based on this information. OpenVPN [10] is used to allow the handheld computers to connect to the server and sync information across the Internet.

The "Open Computer and Software Inventory Next Generation" [11] system is used to perform inventory of IT assets at HBE. OCS-NG collects information about the hardware and software of machines running the OCS client program. GLPI (Gestionnaire libre de parc informatique - Free Management of Computer Equipment) [12] is a frontend for the resulting computer equipment database from OCS. This system has a simple to use GUI and provides a number of reporting tools. Using these systems, it is possible to find who is assigned to what hardware / software and where it is deployed on the network.

D. Portal

Companies or groups of users need a standard location on the network to share and provide common information. A portal is a one-stop central repository to aggregate information that can then be used across an enterprise or business. They allow each user to personalize their experience on the system. These systems provide a number of tools out of the box that can be used to develop and implement an enterprise portal system. Role-based authorization, single sign on, content management, articles, wikis, blogs, message boards, searching, tagging, and RSS feeds are common features. Modern portals also implement portlets to allow for dynamic content in the system. The JSR-286 portal specification to allow for easier integration with other systems. The role-based authorization feature allows different users to be authorized to create, edit, and modify content. This allows different groups to manage their own content.

There are a number of open source applications that can be used to implement a portal. Three possible portals are the Liferay Portal [13], JBoss Portal / eXo platform [14], and jetspeed-2 [15]. HBE chose to build a portal using Liferay Portal. The system is used as a central repository for sales and marketing information, human resources forms, operations details, engineering processes, finance information and IT forms. There is also a wiki and message board that is used to document some activities.

Liferay is a java application that requires an application server. HBE uses Apache Tomcat [16] in this role. The Liferay Portal requires authentication before a user can post documents or customize their views. The jasig Central Authentication Service (CAS) [17] was implemented to provide this functionality. The system provides authentication clients for Java, .Net, PHP, Perl, Apache, and others. HBE has linked user authentication for many applications to CAS based on AD/LDAP.

E. Client-facing Reporting

With the number of systems and data being shared with customers increasing, there is a need for a reporting system that can be used by customers and internal users. This system needs to be scalable, flexible and able to interact with a number data sources. JasperServer [18] Community [19] is a flexible report server that can be integrated with many other applications. It provides a number of query, reporting, and analysis features using a java based platform. The reporting engine can write report results in standard output formats including HTML, Excel, PDF, HTML, CSV, and XML, Flash and Open Office.

JasperServer is used to allow authorized users access to a number of standard reports ranging from inventory lists to PM schedules. Work order history, asset counts, and other standard reports are also available for use through a web interface.

If clients would like to see additional details related to the CMMS that are not available using JasperServer, they may connect to the system using a VPN connection. OpenVPN is used to establish this connection to the server.

F. File servers

When deploying network resources, a company can make the choice to provide local network and file servers in each of the company's offices. If the infrastructure is based on Microsoft's Active Directory, local network servers will provide local access to the global catalog, DNS, DHCP and other services. File servers can be deployed using Microsoft or other operating systems. If a non-Microsoft system is selected for the file servers, the system should have the ability to operate in a Microsoft environment.

Samba [20] is an open source package that provides file and print services to SMB/CIFS (Server Message

Block/Common Internet File System) clients. The system provides interoperability between Microsoft and non-Microsoft platforms, flexibility of services, and choices of hardware platforms in a heterogeneous environment.

HBE uses samba running on a linux platform as the main file server in some of the remote offices. It has been configured to use Active Directory as the source of user and group information for file and directory permissions. Samba is also used to allow internal users access to certain directories on the company's ftp server so they can easily upload or copy a file from the server.

G. Monitoring

Many packages are available to monitor the IT infrastructure. Monitoring of the infrastructure allows the IT staff to know what is happening on the servers and network and if the applications are responding correctly. Monitoring packages also allow the staff to be notified if anything occurs outside a specified performance range. Mission-critical components should be identified and then monitored using some type of package that can provide notifications, event handlers, and reporting. This reporting should include SLA details, outage details, and details of alert responses. A number of packages can be used to perform these tasks. HBE has selected nagios and cacti.

1) *nagios*: Nagios [21] is a system and network monitoring package that observes hosts and services. An action, usually a notification sent to a group, is performed when an event occurs outside a specified threshold. Nagios is able to monitor network services such as mail servers, web servers, and telnet/ssh servers. Host resources such as disk space, CPU load, and network traffic can also be monitored. Contact notifications and escalations can also be configured.

2) *cacti*: Cacti [22] is system using php that utilizes RRDTool [23] for data collection, storage and graphing. Data sources are configured and can be network response times, host parameters, network devices, SNMP data or other sources of information. The system can also use a number of data sources and display the corresponding data using templates. Pre-defined templates make it easy to configure the system for host and network monitoring. Graphs are then presented on the configured data sources.

H. Backups

Lost information can cause a major crisis or worse, lead to business failure. While losing data may not cause financial ruin, it can certainly be frustrating and even heartbreaking. When a data backup is performed, a copy of the data exists outside the primary location of use so it may be restored if it is lost or damaged. In addition to commercial backup software and offsite data storage, HBE is using two open source packages to perform backups.

1) *Unison*: Unison [24] is a file-synchronization tool that can be used on Unix and Windows systems. Unison allows a collection of files to be stored on different systems, modified separately, and then brought up to date by propagating the changes in both directions. HBE uses Unison to create an offsite copy of user files stored on remote Windows file systems. These files are copied using a one-way sync from the remote site to a server in the main data center.

2) *Bacula*: Bacula [25] is a network backup solution that "... comes by night and sucks the vital essence from your computers". Bacula allows system administrators to perform backups and recovery in a heterogeneous environment of linux, Unix, Mac, and Windows systems. Bacula is used at HBE to create grandfather, father, son versions of system snapshots on disk of all of the installed linux systems as well as Unison synced data from other Windows platforms.

I. PBX services

There are many open source packages that provide telephony functionality. These include FreeSWITCH [26], Asterisk [27], sipXecs [28], YATE [29] and Kamailio (OpenSER) [30]. HBE had the need for a PBX system during an office move and as there was some familiarity with Asterisk, it was chosen for deployment in that new office.

1) *Asterisk*: Asterisk is an OSS package that serves as a telephone private branch exchange (PBX). It allows authorized telephones and devices to make calls to each other and connect to the public switched telephone network (PSTN) and Voice over Internet Protocol (VoIP) services. Asterisk offers standard PBX services including voice mail, conference calling, interactive voice response (IVR), and automatic call distribution (ACD). Custom applications can be created using the Asterisk Gateway Interface (AGI). Interface cards are available to connect Asterisk systems to standard telephone interfaces. HBE selected Asterisk-based trixbox [31] as its phone platform in one office. It was also connected to the legacy PBX in another office to provide additional ports.

2) *Hylafax*: Hylafax [32, 33] is a fax server that supports sending and receiving faxes as well as text pages. It is a client-server system with fax modems configured on servers and clients connecting to the server to send fax jobs across the network. A number of users are using hylafax in one of the HBE offices to send fax versions of POs to vendors. It will be configured for incoming fax delivery based on DID telephone numbers in the future. Hylafax can also be configured to send SMS messages. HBE currently has this configured for use with a cellular SMS gateway across a telnet connection but there have been ongoing issues with the operation of this gateway causing messages to be delayed or dropped. There are plans to replace the current gateway with a package that

will send SMS using a cellphone connected directly to the server. A few of the packages under consideration are Sendpage [34], Gammu [35], and gnokii [36].

J. Internal Systems

HBE has a number of internal systems that provide a wide variety of services for both internal and external users. These systems are running on LAMP platforms. LAMP [37] represents a system using Linux (operating system), Apache HTTP Server, MySQL (database software), and PHP (scripting language). The scripting language could also be Perl or Python. XAMPP [38] is a cross platform package offering of LAMP that comes pre-compiled with all of the associated programs and is easy to configure.

There are a number of Apache HTTP servers at HBE that provide reports and data from various systems. Perl scripts have been created to load and extract data associated with OrangeHRM. Perl has also been used to create user accounts in OrangeHRM based on new entries in Active Directory as well as create reports providing a summary of approved job time and industry certifications. The company has automated the testing of analog cameras for a major project and the test results are stored in a MySQL database. Perl is used to create the test reports for each camera. Employee names, pictures, and status information from the access control system are displayed on a WWW page using perl. This script allows everyone to see who is in or out of the building based on who has swiped in or out using their access card. Perl is also used to create a PDF and Excel version of a user telephone directory from Active Directory information. A perl script has been created that notifies users that it is time to submit their time sheets and another script notifies them that their Active Directory password will expire in the near future and they should change it. Perl has also been used to perform ETL (Extract-Transform-Load) functions between the accounting database and the CMMS. Client, job, and service location information is currently transferred. In the near future, job time information will be copied from the CMMS to OrangeHRM and job ticket information will be shared between the CMMS and the accounting system.

PHP scripts within the XAMPP Windows stack have been created to display purchase order and item information from the accounting system. A set of php scripts using jQuery [39] are being written to ease the creation of job information to the accounting system. These scripts will provide error checking on the data and then insert or update the accounting system using ODBC.

The LAMP stack has made it simple to transfer, transform, or display information throughout the mix of systems installed at the company. Phpmyadmin [40] allows for the administration of MySQL over the WWW. The interface provides for the management of databases, tables, fields, indexes, users, and permissions. It allow can be

used to enter SQL statements and then export the data in number of common formats. The MySQL Workbench [41] can also be used to manage MySQL databases using a GUI on Windows and linux systems.

1) *OTRS*: OTRS [42] (Open source Ticket Request System) is a trouble ticket system that can be used to create, assign, and track incoming requests. The system can then be used to track interactions with users while the problem or request is resolved. OTRS::ITSM [43] is a set of modules for OTRS that implement IT Service Management as outlined by the IT Infrastructure Library ITIL (Information Technology Infrastructure Library) V3. OTRS::ITSM provides for Incident Management, Problem Management, Change Management, and Service Asset & Configuration Management (CMDB/CMS). This package is used to track and maintain internal IT work requests and trouble reports from the employees. Users are notified when a ticket is opened and closed and the IT staff is told there is an open requests as well. Tickets are also escalated if they remain open without activity for an extended period of time. Using OTRS allows HBE to manage and report on IT requests from across all offices as well as balance the work between the members of the IT staff.

2) *web2Project*: web2Project [44] is a web-based project management system. The system can be used to manage projects and their associated tasks. web2Project allows users to enter task details and then organize and schedule those tasks. The system can create tasks lists, task schedules, and Gantt charts. HBE uses web2Project in two different ways: The IT group uses the system to manage some larger projects and another part of the business uses it report on the status of open tasks for a particular customer. The customer requests project work using a php interface which stores the data in web2project. The customer can view project information from the system by logging into JasperServer.

3) *Firewall Builder*: Firewall Builder [45] can be used to create and manage firewall configurations for iptables, pf.conf files, Cisco router access lists or PIX configurations. HBE staff uses this package to simplify the configuration of iptable rules used by OpenVPN.

4) *PcHelpware*: PcHelpware [46] is a remote support system that allows users to control a distant computer or provide remote assistance from across a network. Firewall modifications are not required, even if the client is using NAT, if a repeater service is configured. HBE IT staff uses this package to provide direct support for computers in other offices and in the field when employees call in requesting assistance with problems that need to be demonstrated. It is also used from time to time to interact with clients.

5) *ProfFTPD*: ProFTPD [47] is the "Professional File Transfer Protocol (FTP) server daemon". Though the use of modules, it can be configured to provide secure ftp transfers, SSL/TLS support, LDAP and RADIUS support, user quotas, blacklists, traffic shaping, virtual FTP servers,

and chrooted environments. HBE uses proftpd as an external ftp server and then provides access to the ftp content to the staff by sharing the directories to the enterprise network using samba.

6) *Radius*: Radius (Remote Authentication Dial In User Service) [48] is a client/server protocol that provides centralized Authentication, Authorization, and Accounting (AAA) management. As the protocol is an IETF standard, it is available for use by a large number of network devices. FreeRADIUS [49] is a popular RADIUS server and has been installed at HBE. Radius is used to provide authentication for some VPN access, access to network switches and routers, and wireless devices connecting to the network using WPA2.

7) *Rancid*: Rancid [50] (Really Awesome New Cisco config Differ) checks the configuration of network devices and uses CVS (Concurrent Version System) or Subversion to maintain a history of changes. The system logs in to specified devices, obtains information, saves the information, formats the output, emails the differences from the previous collection to a list of managers, and then commits those changes to the revision control system. Rancid supports a number of widely deployed routers and switches from Cisco, Juniper, Foundry, HP, and others. HBE uses rancid to report changes in the configuration of routers and switches.

8) *OpenX*: OpenX [51] is an advertisement server that can be used to manage banners and ads from ad networks. These ads can be displayed on www pages configured with information from the ad servers. Banner management including user/site targeting, time/impressing campaigns, and campaign priorities are performed within the system. HBE uses OpenX on the internal network to provide banner ads related to company announcements and staff recognition.

9) *TCEXAM*: TCEXAM [52] is a Computer Based Assessment (CBA), Computer Based Testing (CBT), or e-exam system. A CBT can be used to create, schedule, deliver and report for quizzes and exams. HBE has used this system to perform assessments after staff training sessions.

IV. DESKTOP SOFTWARE

HBE has used a large number of open source software packages on servers. There are a number of areas where OSS can also be used on the desktop. HBE has deployed a number of these desktop applications. Some of the packages used on the desktop perform text and image editing, work processing, network authentication, multimedia applications, X display, and numerical processing.

notepad++ [53] is a text and source-code editor for Windows. Notepad++ supports auto-completion, file comparing, find and replace over multiple files, and syntax highlighting for many markup and programming languages as well as bracing and indent highlighting. Many of the IT

staff and engineers at HBE use notepad++ as their primary configuration and script editor.

paint.net [54] is a photo and image editing program supporting layers, special effects, and plugins. The user interface is easy to use and allows some of the HBE staff to quickly manipulate image without the overhead of larger image packages.

OpenOffice [55] is an office software suite for word processing, spreadsheets, presentations, graphics, and databases. It can read and write files from other common office software packages. HBE uses this package on laptops belonging to technicians and installers where the full Microsoft Office suite is not needed on a daily basis.

X Supplicant [51] is a supplicant that can be used to authenticate with a RADIUS server using 802.1x on a wired or wireless connection. HBE has experienced known issues on some laptops when attempting to connect to wireless systems using WPA2. Replacing the default supplicant with X Supplicant allows these systems to connect in the desired manner.

vlc [56] is a cross-platform multimedia player capable of reading most audio and video formats as well as many streaming protocols. It can also be used as a media converter or a streaming server. The HBE staff uses vlc to test video and audio streams from network video encoders and IP cameras.

cygwin [57] is a linux-like environment for Windows. It consists of a DLL which acts as a linux API emulation layer and a collection of programs that provides a linux look and feel. Cygwin allows Windows applications, data, and other resources to interact with linux-like applications. Cygwin/X is an implementation of the X Window System running under Windows. HBE has installed cygwin on some servers to ease the configuration of Unison and job scheduling via cron. Cygwin/X has also been used to display X from a linux server back to a Microsoft Windows system.

GNU Octave [58] is a high-level language intended for numerical computations that is mostly compatible with Matlab. Octave can be used for linear algebra, nonlinear equations, integration, polynomials, and differential equations. During some testing that was performed on a project, the resulting data exceeded the capabilities of the graphing function within Excel. Octave was used to display this information and allowed the project to continue.

V. FUTURE

There has been a substantial investment of resources made to the use of OSS at HBE. There continue to be a number of business needs to address and there are plans to implement more OSS on both servers and desktops. These packages include encryption of data on the desktop, data deletion, business process workflow, enterprise resource planning, enterprise content and document management, online analytical processing, intrusion detection, electronic

data interchange, digital signage, learning management systems, firewalls and traffic shaping, and mail archiving.

TrueCrypt [59] provides real-time on-the-fly encryption and is available for many operating systems. TrueCrypt can create a virtual encrypted disk or an encrypted volume that is then available for use. This package may be used on laptops and desktops where file encryption is required. It can also support security tokens using the PKCS #11 (2.0 or later) protocol. HBE is investigating the use of TrueCrypt on laptops used outside the office that may contain sensitive data.

Eraser [60] is a tool for Windows systems that can be used to remove sensitive data from a hard drive by overwriting it with selected patterns many times. It is flexible in how it can be configured or scheduled to operate. HBE is investigating the use of this package when wiping hard drives as systems are retired. It could also be used to delete sensitive information from production systems.

Processmaker [61] is a business process management (BPM) and workflow system. It may be used to design forms, create documents, manage user roles, manage routing rules, and interconnect with existing databases and CRM, ERP, and BI systems. HBE will be investigating the use of Processmaker for expense reports, purchase requisitions, and HR/IT processes.

Openbravo [62] is a web-based enterprise resource planning system providing access to production and customer information, inventory, order tracking, and workflow. Openbravo can also create and export reports and data to PDF and Excel. The area of Openbravo that is an interest to HBE is the inventory control, bill of material generation, and order planning. It may be implemented for use on a large project.

Alfresco [63] is an enterprise content management system. Alfresco includes a content repository providing document, records, image, and collaboration management. HBE is investigating the use of Alfresco as a document management system which will provide the tracking of document access and modifications.

Talend Open Studio [64] and Pentaho BI Project [65] are data integration packages providing data mining, workflow, business intelligence, online analytical processing (OLAP) and ETL (Extract-Transform-Load) functionality. ETL and OLAP are both areas of interest to HBE.

Snort [66] is a network intrusion prevention system (NIPS) and network intrusion detection system (NIDS). It can be used to detect and actively block network attacks and probes. While network security is already in place across the HBE offices, the flexibility that is provided by snort is something that is desired.

Electronic Data Interchange (EDI) is the exchange of electronic business data between companies. It is used to transfer information from one business partner to another. bots [67] is open source EDI software. HBE is looking into the use of EDI with vendors to obtain product catalog

information and ordering details. Pricing, availability, and inventory levels could all be loaded and processed using EDI.

Digital signage [68] is a form of electronic display that shows information, advertising and other messages. There are two active open source packages that provide this functionality: Xibo [69] and concerto [70]. Both packages provide for multiple displays, multiple zones, and scheduled deployment of a wide range of media. HBE is investigating the use of digital signage for both internal and external use.

A learning management system (commonly abbreviated as LMS) is a software application for the administration, documentation, tracking, and reporting of training programs, classroom and online events, e-learning programs, and training content [71]. Moodle (Modular Object-Oriented Dynamic Learning Environment) [72] and Sakai [73] are e-learning platforms that can be used in education, training, and business environments. HBE has started the process of reviewing LMSs for internal and external use. They could be implemented to provide training for staff in HR and technical areas.

There is a need to provide firewalls, NAT, VPN, and traffic shaping at the edge of the remote office locations. There are many open source packages that can be used that will cover some or all of these requirements including m0nowall [74], pfsense [75] and shorewall [76]. The tc (traffic control) program in linux can be used to modify traffic based on source/destination and type of traffic. Tc is already used by HBE to prevent remote backups from saturating WAN connections. It will be used during LAN backups as well to minimize CPU and bandwidth load on a desktop system.

Legislation such as the Sarbanes Oxley Act (SOX), Gramm-Leach Bliley Act (GLBA), and the Freedom of information Act (FOIA) requires businesses to archive email under some situations. Email archiving provides a means of storing, searching, and retrieving a copy of all inbound/outbound internal/external mail messages and storing them in a centrally manage location. An open source package that provides this functionality is Mailchiver [77]. HBE has investigated the use of this mail archiving system.

VI. CONCLUSION

Henry Bros. Electronics (HBE) has been deploying a wide variety of open source systems over the last two years. There can be advantages and disadvantages of using open source software. The advantages include that the software is free, the base code is secure and peer-reviewed, it allows for quick innovation and users are not tied to a single vendor. There are also disadvantages in using OSS including a learning curve and lack of support for some projects. Systems can also be difficult to maintain if they are not upgraded and managed over time. Many business

may implement OSS but obtain a support contract for critical systems. HBE has implemented a large number of open source software packages to provide functionality to the business where nothing existed before or there was a need to enhance an existing package or platform. In many cases, these systems would not have been implemented had there been a cost associated with the purchase of the software. In all cases, there was some level of internal support required to implement and integrate the system into the existing environment. OSS has been used to provide sales lead tracking, time reporting, asset management, portal functionality, a reporting engine, file services, monitoring services, backups, PBX functionality, and a number of internal systems. OSS has also been used to extend the functionality of the desktop in the areas of text and image editing, work processing, network authentication, multi-media applications, X display, and numerical processing.

There has been a substantial investment of resources made to the use of OSS at HBE. There continue to be a number of needs to address and there are plans to implement more OSS on both servers and desktops. The flexibility and functionality of available OSS can allow a company to increase its efficiencies and level of operations if the systems can be installed and maintained in an efficient manner.

REFERENCES

- [1] Wikipedia, "Open-source software," Wikipedia, March 2010. [Online]. Available: http://en.wikipedia.org/wiki/Open_source_software
- [2] "The open source definition (annotated)," The Open Source Initiative, March 2010. [Online]. Available: <http://www.opensource.org/docs/definition.php>
- [3] M. Bloch, "Open source software in your online business - advantages/disadvantages," Taming The Beast, 2010. [Online]. Available: <http://www.tamingthebeast.net/articles5/open-source-software.htm>
- [4] "Advantages and disadvantages of the open source software suck as linux," Open Source Technology, June 2008. [Online]. Available: <http://opensource technologies.blogspot.com/2008/06/advantages-and-disadvantages-of-open.html>
- [5] Bartc, "The cost of open source software," Activestate, February 2010. [Online]. Available: <http://blogs.activestate.com/2010/02/the-cost-of-open-source-software>
- [6] J. McKendrick, "Why open source software isn't exactly 'free,' but offers other advantages," Insurance Networking News, February 2010. [Online]. Available: http://www.insurancenetworking.com/blogs/insurance_technology_open_source_Oracle_MySQL-24207-1.html
- [7] "Sugarcrm," SugarCRM, March 2010. [Online]. Available: <http://www.sugarforge.org/>

- [8] "Orangehrm," OrangeHRM, March 2010. [Online]. Available: <http://www.orangehrm.com/>
- [9] "Calemeam," CaleMEAM, March 2010. [Online]. Available: <http://www.calemeam.com/>
- [10] "Openvpn," OpenVPN, March 2010. [Online]. Available: <http://www.openvpn.org/>
- [11] "Ocs inventory ng," OCS Inventory NG, March 2010. [Online]. Available: <http://www.ocsinventory-ng.org/>
- [12] "Gestionnaire libre de parc informatique," Jean-Mathieu Doleans and Frederic Ginioux, March 2010. [Online]. Available: <http://www.gipi-project.org/spip.php?lang=en>
- [13] "Liferay portal," Liferay, March 2010. [Online]. Available: <http://www.liferay.com/>
- [14] "Jboss portal / exo platform," JBoss, March 2010. [Online]. Available: <http://www.exoplatform.com/>
- [15] "Jetspeed-2," Apache, March 2010. [Online]. Available: <http://portals.apache.org/jetspeed-2>
- [16] "Tomcat," Apache, March 2010. [Online]. Available: <http://tomcat.apache.org/>
- [17] "Central authentication service," JASIG, March 2010. [Online]. Available: <http://www.jasig.org/cas>
- [18] "Jasperserver," Jaspersoft, March 2010. [Online]. Available: <http://www.jaspersoft.com/jasperserver>
- [19] "Jasperserver community," Jaspersoft, March 2010. [Online]. Available: <http://jasperforge.org/projects/jasperserver>
- [20] "Samba," Samba, March 2010. [Online]. Available: <http://www.samba.org/>
- [21] "nagios," nagios, March 2010. [Online]. Available: <http://www.nagios.org/>
- [22] "cacti," cacti, March 2010. [Online]. Available: <http://www.cacti.net/>
- [23] "Rrdtool," RRDTool, March 2010. [Online]. Available: <http://oss.oetiker.ch/rrdtool>
- [24] B. C. Pierce, "Unison file synchronizer," University of Pennsylvania Computer and Information Science, Philadelphia, March 2010. [Online]. Available: <http://www.cis.upenn.edu/~bcpierce/unison/index.html>
- [25] "Bacula," Bacula, March 2010. [Online]. Available: <http://www.bacula.org/>
- [26] "Freeswitch," FreeSwitch, March 2010. [Online]. Available: <http://www.freeswitch.org/>
- [27] "Asterisk," Digium, March 2010. [Online]. Available: <http://www.asterisk.org/>
- [28] "sipxecs," Sip Foundry, March 2010. [Online]. Available: <http://www.sipfoundry.org/>
- [29] "Yate," YATE, March 2010. [Online]. Available: <http://yate.null.ro/pmwiki>
- [30] "Kamailio (openser)," Kamailio, March 2010. [Online]. Available: <http://www.kamailio.org/w/>
- [31] "Trixbox," Trixbox, March 2010. [Online]. Available: <http://www.trixbox.org/>
- [32] "Hylafax," Hylafax, March 2010. [Online]. Available: <http://www.hylafax.org/>
- [33] "Hylafax plus," Hylafax plus, 2010. [Online]. Available: <http://hylafax.sourceforge.net/>
- [34] "sendpage," sendpage, March 2010. [Online]. Available: <http://www.sendpage.org/>
- [35] "Gammu," Gammu, March 2010. [Online]. Available: <http://www.gammu.org/>
- [36] "gnokii," gnokii, 2010. [Online]. Available: <http://www.gnokii.org/>
- [37] "Lamp software bundle," Wikipedia, March 2010. [Online]. Available: [http://en.wikipedia.org/wiki/LAMP_\(software_bundle\)](http://en.wikipedia.org/wiki/LAMP_(software_bundle))
- [38] "Xampp for windows," apache friends, March 2010. [Online]. Available: <http://www.apachefriends.org/en/xampp.html>
- [39] "jquery," jQuery, March 2010. [Online]. Available: <http://www.jquery.com/>
- [40] "phpmyadmin," phpMyAdmin, March 2010. [Online]. Available: <http://www.phpmyadmin.net/>
- [41] "Mysql workbench," MySQL, March 2010. [Online]. Available: <http://dev.mysql.com/downloads/workbench/5.2.html>
- [42] "Otrs," OTRS, March 2010. [Online]. Available: <http://otrs.org/>
- [43] "Otrs:itsm," OTRS, March 2010. [Online]. Available: <http://www.otrs.com/en/products/otrsitsm>
- [44] "web2project," web2project, March 2010. [Online]. Available: <http://web2project.net/>
- [45] "Firewall builder," Firewall Builder, March 2010. [Online]. Available: <http://www.fwbuilder.org/>
- [46] "Pchelpware," uVNC, March 2010. [Online]. Available: <http://www.uvnc.com/pchelpware>
- [47] "proftpd," proftpd, March 2010. [Online]. Available: <http://proftpd.org/>
- [48] "Radius," Wikipedia, March 2010. [Online]. Available: <http://en.wikipedia.org/wiki/RADIUS>
- [49] "freeradius," freeRadius, March 2010. [Online]. Available: <http://freeradius.org/>
- [50] "rancid - really awesome new cisco config differ," Shrubbery Networks, Inc., March 2010. [Online]. Available: <http://www.shrubbery.net/rancid>
- [51] "Openx," OpenX, March 2010. [Online]. Available: <http://www.openx.org/>
- [52] "Tcexam," tecnick.com, March 2010. [Online]. Available: http://www.tecnick.com/public/code/cp_dpdp.php?aiocp_dp=tcexam
- [53] "notepad++," notepad++, 2010. [Online]. Available: <http://notepad-plus.sourceforge.net/uk/site.htm>
- [54] "paint.net," paint.net, 2010. [Online]. Available: <http://www.getpaint.net/>
- [55] "Openoffice," Oracle, 2010. [Online]. Available: <http://www.openoffice.org/>
- [56] "Vlc media player," VideoLAN, March 2010. [Online]. Available: <http://www.videolan.org/vlc/>
- [57] "cygwin," cygwin, 2010. [Online]. Available: <http://www.cygwin.com/>

- [58] "Octave," University of Wisconsin, 2010. [Online]. Available: <http://www.gnu.org/software/octave/>
- [59] "truecrypt," 2008. [Online]. Available: <http://www.truecrypt.org/>
- [60] "Eraser," 2010. [Online]. Available: <http://eraser.heidi.ie/>
- [61] "Processmaker," 2010. [Online]. Available: <http://www.processmaker.com/>
- [62] "Openbravo," 2010. [Online]. Available: <http://www.openbravo.com/>
- [63] "Alfresco," 2010. [Online]. Available: <http://www.alfresco.com/>
- [64] "Taland studio," 2010. [Online]. Available: <http://www.talend.com/>
- [65] "Pentaho," 2010. [Online]. Available: <http://www.pentaho.com/>
- [66] "snort," 2010. [Online]. Available: <http://www.snort.org/>
- [67] "bots," 2010. [Online]. Available: <http://bots.sourceforge.net/en/index.shtml>
- [68] Wikipedia, "Digital signage," 2010. [Online]. Available: http://en.wikipedia.org/wiki/Digital_signage
- [69] "Xibo," 2010. [Online]. Available: <http://xibo.org.uk/>
- [70] "concerto," 2010. [Online]. Available: <http://www.concerto-signage.com/>
- [71] R. K. Ellis, "Field guide to learning management systems," *ASTD Learning Circuits*, 2009. [Online]. Available: http://www.astd.org/NR/rdonlyres/12ECDB99-3B91-403E-9B15-7E597444645D/23395/LMS_fieldguide_20091.pdf
- [72] "moodle," 2010. [Online]. Available: <http://moodle.org/>
- [73] "Sakai," 2010. [Online]. Available: <http://sakaiproject.org/>
- [74] "monowall," 2010. [Online]. Available: <http://m0n0.ch/wall/documentation.php>
- [75] "pfsense," 2010. [Online]. Available: <http://www.pfsense.org/>
- [76] "Shorewall," 2010. [Online]. Available: <http://www.shorewall.net/>
- [77] "Mailarchiva," 2010. [Online]. Available: <http://www.mailarchiva.com/>

operation of services and support.

Miguel Rodriguez is a Senior Systems Administrator/Integration for Henry Bros. Electronics and a retired Marine. He received a BS from New Jersey City University. He has over 15 years of experience in information technology. Mr. Rodriguez worked for Internal Paper, Inc. as a Programmer Analyst for the accounting department and more recently was employed with TradeCard as Head of Datacenter Services, overseeing day-to-day operations.

Christopher Peckham is the CIO/CSO of Henry Bros. Electronics, a provider of technology-based integrated electronic security systems, services and emergency preparedness consultation to commercial enterprises and government agencies. He received the BS, MS, and PhD in electrical engineering from NJIT and an MBA from Rutgers University. He has served in a variety of senior information technology, network engineering and operations positions during his 20-year career. Chris is a strong proponent of the use of open source software. He has experience in planning, developing, and implementing solutions to address business opportunities including the development of strategic and tactical plans for implementation and