A Survey of Linux Systems in Higher Education Environments

Authors:

Joannie Yen, Florida Atlantic University, FL 33431, joanniey@hotmail.com
Sam Hsu, Florida Atlantic University, FL 33431, sam@cse.fau.edu

Abstract *— The purpose of this paper is to report on a survey of computer labs in public universities throughout the US states that are running the Linux Operating System. A total of 7152 computer labs from 559 public universities have been surveyed online. It has been found that only 169 computer labs are classified as Linux labs, about 2.3 percent out of the thousands of labs surveyed. This is an interesting, yet counter-intuitive finding. Linux is most ideal for schools with limited budget because it does not require expensive hardware, and it provides free software and open source format that can be modified to suit individual needs. Since its initial development a decade ago in the premises of the University of Helsinki, Linux was adopted early on by many universities' research departments. Its popularity in college campuses ought to be higher than the commercial Linux applications. Yet the academic Linux applications are found lagging far behind with a usage ratio of only 2.3 percent, as opposed to the reported 23.1 percent worldwide Linux server market and 2.8 percent Linux-based client operating systems popularity in the business world. The collected data are also grouped into seven geographical regions: New England, Mid Atlantic, Midwest, Plains, South, Mountains and West Coast to observe if location makes any marked difference in the Linux popularity. It is observed that West Coast has the highest rate of 3.3 percent, whereas New England has the lowest rate of 0.6 percent. All other regions have rates between 2 and 3 percent. Since the majority of the Linux labs surveyed are hosted either in a Science or Engineering college, further efforts have been made to relate connections between higher ranking engineering schools and higher number of Linux labs. However, no noticeable correlation has been established between the last two, based on the survey data.*

Index Terms — Free Software, Linux, Open Source

INTRODUCTION

Linux [1][2] is often described as a free version of UNIX, and there is good reason for it. The blueprint for what the Linux code would do is the POSIX (Portable Operating System Interface) standards [3]. POSIX stipulates an industry standard for operating systems that every major version of UNIX has complied with. Linux has all the features one would expect in a modern fully-fledged UNIX operating system, including true multitasking, virtual memory, shared libraries, demand loading, shared copy-on-write executables, proper memory management, and TCP/IP networking. Linux is legally covered by the GNU[1] General Public License which allows distribution of free software on request [4]. Changes to the software by any user are permitted since GNU allows removal of bugs and as well as feature-additions, etc. Because the source code for the software is freely available, many software developers throughout the world have worked on Linux, fixing bugs, adding new features, and again, have redistributed it freely. It has become the common platform that power users of the computer world are eagerly searching for. Although Linux was first developed for 32-bit x86-based PCs (386 or higher), these days it runs on a variety of different modern hardware platforms, such as the Compaq Alpha AXP, Sun SPARC and UltraSPARC, Motorola 68000, PowerPC, PowerPC64, ARM, Hitachi SuperH, IBM S/390, MIPS, HP PA-RISC, Intel IA-64, DEC VAX, AMD x86-64 and CRIS architectures [2]. Linux provides software compatibility for most new applications or utilities the market offers. Various Graphical User Interfaces (GUIs) for easy navigability such as KDE[2] and GNOME[3] are also included as part of the Linux package.

Nowadays, Linux has been widely used in the academic environment [5]. There is also a call for Linux to be the new international standard for computing in higher education [6]. In the business environment, Linux has gained a significant foothold in it, thanks to the backing of computer giants like HP, IBM and other big players in the industry such as Dell, Oracle, Sun, and Novell. It has been reported [7][8] that Linux enjoys 23.1 percent server market and 2.8 percent desktop market in the business world. Since Linux has been embraced by both research departments in universities and in business as

[1] GNU stands for "GNU is not UNIX."
[2] http://www.kde.org/
[3] http://www.gnome.org/

well from the beginning, their progresses would be expected to be in parallel. To confirm whether Linux is just as popular in the educational world as in the business world, we conducted a survey to search public universities throughout the 50 US states and District of Columbia for Linux-based labs. As many as 7152 computer labs from 559 US universities were surveyed online during the period from September 2003 to February 2004. It is to our surprise that Linux only accounts for about 2.3 percent of the computer operating systems usage in the academia.

THE SURVEY

This survey on Linux systems in higher education environments was performed online via the Internet. We began by visiting each of the states in alphabetical order. Only the public schools that offer bachelor or higher degrees were included in the survey. Virtual schools were excluded. At the Web site for each school, a general lab description was accessed via relevant links searching for key words such as "computing", "academic computing", and "information technology". Any lab that had installed Linux operating system was categorized as a "Linux lab", if it provided services that could be classified either as a Linux server, client, or for general purpose use. If a school's computer labs information was not searchable at all, then the school was counted as "NA" on the resulting data sheet. A total of 7152 computer labs from 559 public universities throughout the US states were surveyed.

The collected data were analyzed and organized into three tables. Table 1 sums up the total universities, labs, Linux labs and "NA" schools surveyed. It provides a measuring base to determine the Linux popularity within college campuses. Table 2 divides the data into seven geographical regions: New England (Maine, Vermont, Massachusetts, Connecticut, Rhode Island), Mid Atlantic (New York, Pennsylvania, New Jersey, Delaware, Maryland, West Virginia, Virginia, Washington D. C.), Midwest (Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Kentucky, Missouri), South (North Carolina, Tennessee, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas), Plains (North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas), Mountains (Colorado, Wyoming, Montana, Idaho, Utah, New Mexico, Nevada, Arizona), and West Coast (Alaska, Washington, Oregon, California, Hawaii). The purpose is to observe any possible relations between a geographic location and a new technology. Table 3 lists the fifteen universities that have the most Linux labs as well as their applicable ranking from the US News and World Report survey of the best graduate engineering schools [9]. Because the majority of Linux labs are hosted by either a Science or Engineering college, higher ranking engineering schools may have adopted Linux technology more than the other schools.

During the survey process we observed that university websites vary in many different ways. For example, some are very user friendly, such as the one by University of California at San Diego. Quite a few of them do not offer much information. Instead, they require some kind of direct contact. However, several earlier attempts to obtain information by email were unsuccessful. Iowa State University, as another example, has detailed information for each of its computer labs including departmental labs as well as labs run by its Academic Computing Services. Some universities would not even list all of their labs and the labs that were listed had minimal information such as just open hours. Furthermore, universities are constantly updating and changing the information that is being placed on the Web. The data collected is current only at the time being surveyed.

Findings

From the data collected, we have learned that:

1. Despite the increasing use of Linux in business and industry, Linux usage is not as widely used in public colleges and universities as had been expected. The overall percentage is 2.28% on college campuses, which is less than the 2.8% Linux desktop market share in the business world, and the gap is even much larger as compared to the 23.1 Linux server market share.
2. Linux usage is distributed across all US states and is not confined to one or a few regions.
3. Region-wise, West Coast has the highest rate of 3.3 percent, whereas New England has the lowest rate of 0.6 percent. All other regions have rates between 2 and 3 percent.
4. As had been expected, Linux is found mostly in computer science and engineering lab environments. High ranking engineering schools do not necessary embrace Linux technology more than other schools.

Note: About 19% of the total schools surveyed do not have computer lab information available online. It could make some impact on the survey findings here if those schools would update their websites to include lab configurations. However, we do not expect it would change significantly the overall contour of this survey results.

CONCLUSION

Compared to the popular use of Linux in the business world, the academia is lagging behind in its efforts to make Linux available for student use. The large advances of Linux in the public and private sector mean that more jobs will require detailed knowledge and experience with Linux. Universities should keep up with the trend to prepare their students for this new job environment. Other than adding more Linux classes to the curriculum, campus computer labs with Linux operating systems should be readily available to all students in order that a good balance of classroom and practical lab work can be achieved. In addition, college budgets are constantly under pressure to make do with less money, and Linux with the advantages of low cost and reliability offer an excellent cost effective solution to university computer needs. To conclude, we would like to make this survey a useful baseline for subsequent surveys. Future statistics may reference today's data to see if there is a marked increased use of Linux in the academic community.

FIGURES, AND TABLES

TABLE 1
GENERAL DATA

State	Number of Universities	Number of Labs	Labs with Linux	N/A (Univ. w/o Lab Info)
ALABAMA	18	59	6	5
ALASKA	3	81	2	1
ARIZONA	4	98	8	0
ARKANSAS	9	46	1	2
CALIFORNIA	35	531	20	1
COLORADO	13	223	5	1
CONNECTICUT	6	108	1	1
DELAWARE	2	34	0	0
FLORIDA	13	108	4	1
GEORGIA	20	195	2	5
HAWAII	3	4	0	0
IDAHO	4	80	0	0
ILLINOIS	16	288	2	3
INDIANA	12	321	4	0
IOWA	3	120	10	0
KANSAS	9	95	0	0
KENTUCKY	8	108	0	2
LOUISIANA	15	176	3	2
MAINE	8	63	0	1
MARYLAND	15	168	8	3
MASSACHUSETTS	13	44	0	7
MICHIGAN	15	241	6	3
MINNESOTA	14	143	7	3
MISSISSIPPI	7	16	1	5
MISSOURI	12	155	3	2
MONTANA	7	27	4	2
NEBRASKA	7	71	1	1
NEVADA	3	50	2	1
NEW HAMPSHIRE	4	42	1	0
NEW JERSEY	10	204	7	1
NEW MEXICO	7	58	1	1
NEW YORK	42	490	9	15
N. CAROLINA	16	212	11	4
NORTH DAKOTA	6	4	0	3
OHIO	15	304	6	3
OKLAHOMA	13	80	1	6
OREGON	8	80	0	1
PENNSYLVANIA	19	344	6	3
RHODE ISLAND	2	12	0	0
S. CAROLINA	13	148	2	0
SOUTH DAKOTA	7	119	1	1
TENNESSEE	10	280	4	1
TEXAS	31	264	10	8
UTAH	5	85	0	0

TABLE 1
GENERAL DATA (CONT.)

VERMONT	5	62	0	2
VIRGINIA	16	198	2	1
WASHINGTON	8	70	4	0
WASHINGTON D. C.	2	3	0	1
WEST VIRGINIA	11	83	0	3
WISCONSIN	14	295	3	0
WYOMING	1	62	0	0
TOTAL	559	7152	169	106

TABLE 2
REGIONAL DATA

Region	Number of Universities.	Number of Labs.	General Linux Labs	Departmental Linux Labs	% with Linux
New England ME,VT,NH, MA,CT, RI	38	331	1	1	0.6
Mid Atlantic NY,PA,NJ,DE,MD, WV,VA,DC	117	1526	5	28	2.16
Midwest OH,MI,IN,IL,WI,MN,IA,KY,MO	109	1975		41	2.07
South * NC,TN,SC,GA,FL,AL,MS,LA,AR	121	1240		34	2.74
Plains ND,SD,NB,KS,OK,TX	73	633	3	10	2.05
Mountains CO,WY,MT,ID,UT,NM,NV,AZ	44	683		20	2.92
West Coast AK,WA,OR,CA,HW	57	766	1	25	3.39

* In the South region, every state has at least one Linux lab.

TABLE 3
TOP 15 SCHOOLS WITH MOST LINUX LABS

State	University	Number of Linux Labs	College/Department	US News School Ranking
IOWA	UNIV. OF NORTHERN IOWA	10	Natural Science	
NORTH CAROLINA	N. CAROLINA STATE UNIV.	9	Sciences / Engineering	32
CALIFORNIA	U C SAN DIEGO	7	Science/Engineering/Music	
MARYLAND	UNIV. OF MARYLAND BALTIMORE COUNTY	7	Information Technology	
NEW JERSEY	NEW JERSEY INSTITUTE OF TECHNOLOGY	5	Computer & Information Science/Math	
NEW YORK	SUNY BUFFALO	5	IT/Science & Engineering	
TEXAS	U T AUSTIN	5	Engineering	10
ALABAMA	UNIV. OF ALABAMA HUNTSVILLE	4	Computer Science	
ARIZONA	ARIZONA STATE UNIV. EAST	4	Information Technology	
ARIZONA	UNIV. OF ARIZONA	4	CS/Physics/Fine Arts	
CALIFORNIA	CALIFORNIA STATE UNIV. LONG BEACH	4	Computer Science & Engineering	
MINNESOTA	UNIV. OF MINNESOTA	4	Information Technology	23
FLORIDA	UNIV. OF FLORIDA	3	Computer Information Science & Engineering	27
OHIO	UNIV. OF AKRON	3	Engineering/Applied Math & CS	
MONTANA	UNIV. OF MONTANA	3	Computer Science	

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