

A QUALITATIVE STUDY OF THE LINUX OPEN SOURCE COMMUNITY

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This paper explores the factors and mechanisms underlying the evolution of the LINUX software and community. A study was done to investigate the development process of the open source culture in general, with an emphasis on the growth and current issues related to LINUX. In addition to studying the history of LINUX and the open source movement, a survey of how LINUX users and developers perceive the LINUX phenomenon was undertaken by posting a questionnaire to two Internet Linux newsgroups: comp.os.linux.development.system and comp.os.linux.misc. Results showed that people appreciate the freedom LINUX offers – both freedom to modify and customize to one's needs as well as freedom from paying for the software. Contributions to the system noted that giving away their work gave them inherent pleasure and also brought personal recognition. Factors that led to LINUX success and sustainability include a strong leader and good Internet communication infrastructure.

Headings:

Community collaboration

Community - open source

Qualitative Study

Software development

Software - open source

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Introduction

In the past few years, it was hard for Information Technology (IT) professionals not to notice a new movement in the computer software world: the LINUX operating system. LINUX is gaining attention beyond the IT community because it is a leading example of open source software that is available for free to anyone who wants to use it. It has been a topic covered by various news media from trade magazines to popular newspapers. For example:

- **CNN** on 12/15/98, listed 'LINUX becomes a household name' as the third
The Top 10 IT News Stories of 1998'. [1]
- **The News & Observer Sunday Business** dated 1/17/99, in its feature story
'The Mad Hatter' stated "(LINUX) is more than just a piece of software. It
- **Time** magazine, in its own version of 1998 top ten stories, included 'The
Rise of LINUX', in which it said "LINUX is different from Windows and
Macintosh in two crucially important ways: It's free. And it doesn't crash."
[2]
- **CNN** on 8/22/98, an article 'How LINUX got so quoted from
Keith Dart, a test engineer at Cisco Systems in Santa Clara, Calif., "I chose
LINUX because it is far more stable and functional than the alternatives. My
system has never crashed." Dart "employs LINUX for everyday

applications, such as word processing, spreadsheets and presentations, also for special projects, such as the testing of products.” [3]

LINUX does not have the limitations of commercial operating systems. It freely distributes both the software and the source code via the Internet. That means no matter where a person is geographically located, as long as he/she has an Internet connection, he/she can get LINUX software as well as the nuts and bolts of how the software works for free! For people who don't have access to the Internet, some companies bundle the same amount of resources on CD-ROM and distribute it. The users only pay for the overhead of CD-ROM production and distribution.

It is important to clarify what is an operating system. An operating system (OS) is the software that controls a computer's resources and manages the computer's tasks [4]. An OS software is composed of a collection of programs. Some of the programs work as a kernel - the part that arranges and organizes files, keeps track of memory resources, and coordinates the use of the computer's main processor. Others are utilities and applications - programs built around the kernel and provide an interface for the user to interact with the computer to get something done. Some examples of utilities are user programs and development tools. In short, an operating system gives people the power to use the computer hardware. Without an OS, a computer is no more than a box filled with many interconnected electric circuits that gives off heat. Some well known operating systems are DOS, Windows NT, Macintosh, UNIX, LINUX, etc. The first three operating systems

are commercial software, which means users can only purchase the right to use the software but not the details of how the software works.

Compared to proprietary OS systems which support limited platforms, LINUX supports a much larger variety of cross-brand hardware platforms, including Intel 80x86 systems, Macintosh, Sun SparcStations, and DEC Alpha based systems.

It is fair to say that LINUX is at least as reliable and robust as any commercial operating systems, only at no or very low cost but with wider hardware flexibility.

In today's market economy, it seems common sense that the value of anything concrete like software should be in positive proportion to its monetary cost. Apparently, LINUX is not following this rule in that on one hand, its reliability and robustness make it significantly valuable to users. On the other hand, its distribution to users can be free of charge. This contradiction to common sense is one of the things that causes so much interest in LINUX.

Then a question is unavoidable, how could this seemingly insensible phenomenon happen and be sustained? This paper explores this puzzling, yet interesting question.

Literature Review

LINUX as a kernel was developed by Linus Torvalds (Linus) in 1991, when he was a college student at the University of Helsinki in Finland. At that time it was nothing but his hobby project. According to an interview with Linus Torvalds in February 1999 conducted by MSNBC [5], the source code of the original release had about 10,000 lines with only a couple of utilities workable. Now LINUX kernel has 15,000,000 lines, most of which were written by volunteers around the world rather than Linus himself. It is no doubt that this hobby project of a student has developed into a reliable and fully-fledged operating system. To have a general idea about how this happened, we must consider the following factors:

- Internet – where LINUX was known to people around the world
- UNIX OS– what LINUX was modeled after
- Personal computer (PC) – the platform LINUX was originally based on
- GNU project – where many freely distributable utility software modules were developed and have largely been adopted by LINUX.
- Open source model – which serves as the guideline for the development and distribution of LINUX

Internet

The word "internet" literally means "network of networks." A network is composed of computers connected to each other to exchange data. The Internet (with capital I) we are using today is the super network that interconnects pieces of networks scattered all over the world. It originated from a US defense project in the late 1960s. The original goal was to design a computer network that would allow the military to communicate in case of a nuclear war. That means every computer on the network should be able to communicate, as a peer, with every other computer on the network. Thus if part of the network was destroyed, the surviving parts would automatically detour around it and continue to talk with one another [6]. This is exactly how today's Internet works.

However, in the beginning no technology was ready to implement the idea. During the years afterwards, various protocols – rules computers must follow to exchange messages – were developed. Since the protocols are all open to the world, everyone can develop applications based on them. One of the applications is electronic bulletin board system (BBS) which allows individuals to post electronic messages at some networked computer storage so people having access to the storage can share or exchange information. The BBS consists of computer programs to keep all the messages and send them out in response to valid requests.

The major BBS service available on the Internet is called network news, often abbreviated netnews. The netnews system uses the term newsgroup to refer to each individual bulletin board (i.e., each discussion group). Netnews originated as part of an

early computer network that used dial-up modems to place telephone calls between computers and exchange information. Originally, sites exchanging network news over dial-up connections used the term USENET to refer to their “network” of computers. With the growth of USENET and Internet, other connection technologies emerge to transmit network news among the participating sites and many sites now have Internet access. The term USENET now refers collectively to all sites that participate in the exchange of network news, regardless of the type of network they use. [8]

USENET Newsgroups (newsgroups) are formed by people interested in certain topics such as computers, politics, education, cooking, and so on. The underlying mechanism of BBS makes sure that a copy of each article posted to a newsgroup is available to every participant in the newsgroup.

Newsgroups have been very popular ever since its inception. By early 1997 it included over 7000 separate newsgroups divided into nearly 200 categories [8]. In newsgroups, group members share some common interest, and voluntarily offer help to other’s problems. Consequently, a sense of community is fostered among the group members. Unlike in physical communities where people’s physical locations are the key to keep them together, in newsgroup communities, it is the shared interest and the willingness to help each other that connect people together from all over the world. To differentiate them from physical communities, communities formed via computer networks are referred to as online or virtual communities.

In the LINUX world, online community has played an indispensable role in the development of the software. It has always been the place where developers and users exchange information on the software they have been working on. The nature of online communication does not require participation in the communication to be synchronous. It allowed people to work on the same project at their own pace and time schedule. Therefore, time and place differences are no longer barriers among the geographically isolated developers. Everybody involved has complete flexibility and autonomy.

UNIX

In the early 1970s, a team of computer scientists at AT&T's Bell Telephone Laboratories (Bell Labs) developed a multitasking operating system - more than one task can be handled at the same time – for minicomputers and mainframes. They called it the UNIX Timesharing System [8] and shared the source code with the University of California at Berkeley. Later Berkeley developed their own version of UNIX which is all free of any Bell Labs' code – BSD (Berkeley Standard Distribution).

Bell Labs also allowed other universities to obtain free copies of the UNIX system for use in teaching and research. One of the features Bell Labs were interested in measuring was the portability of UNIX, so they provided its source code and encouraged universities to try running it on different kinds of platforms. As a result, the UNIX system became one of the first operating systems that students could study and versions of UNIX exist for many platforms from personal computers to supercomputers.

UNIX was further developed by both academic researchers and commercial vendors. On the academic side, BSD version has many variations. In the business world, besides AT&T, Sun, Hewlett-Packard and others have also developed their own versions of UNIX. The differences among the various UNIX versions are at the OS level, so they are almost transparent to the end users, but apparent to the system administrators. The scalability and robustness of UNIX have made it very popular in big organizations. Coming with the sophistication of the system is its high cost.

Personal Computer

In the early 1980s, IBM combined an Intel microprocessor with Microsoft's DOS operating system and introduced its model of personal computer. [6] This became a standard model of personal computers in the market and initiated a PC movement in the mainframe prevalent computer world. Soon the affordable price and the power of the PC pushed it into common households.

Before 1985, neither Intel's microprocessor - the hardware, nor DOS OS - the software, could support multitasking. But in 1985, Intel introduced the 80386 microprocessor, which was powerful enough to handle multitasking. Thus if a computer with 80386 microprocessor or above couldn't support multitasking, it is because of the limitation of the operating system (e.g. DOS). As mentioned above, unlike DOS, UNIX is a multitasking operating system. It is easy to imagine that people would like to run UNIX in their personal computers at home, so they can keep a number of applications open at

the same time and easily switch among them. But the problem was that although versions of UNIX for PCs existed during the DOS era, they were far more expensive than DOS.

Some programmers, who wanted to have UNIX running on their PCs without paying too much, started working on their own versions of UNIX for PCs. Minix was one of them. It was a simple UNIX like operating system working on Intel-based PCs and widely used as a teaching aid. Linus was a MINIX user and was in the MINIX newsgroup. But he found himself less and less impressed with MINIX features. So he decided to work on a completely new UNIX-like system, and started writing source code based on an Intel 386 PC.

On October 5, 1991, Linus announced the first ``official" version of LINUX, version 0.02 in the MINIX newsgroup - comp.os.minix:

``Do you pine for the nice days of Minix-1.1, when men were men and wrote their own device drivers? Are you without a nice project and just dying to cut your teeth on an OS you can try to modify for your needs? Are you finding it frustrating when everything works on Minix? No more all-nighters to get a nifty program working? Then this post might be just for you.

``As I mentioned a month ago, I'm working on a free version of a Minix-look-alike for AT-386 computers. It has finally reached the stage where it's even usable (though may not be, depending on what you want), and I am willing to put out the sources for wider distribution. It is just version 0.02...but I've successfully run bash, gcc¹, gnu-make, gnu-sed, compress, etc. under it." [7]

Apparently Linus' idea was echoed by many challenge-seeking developers. In an interview with Linus conducted by MSNBC in early 1999, Linus disclosed that there

¹ gcc, gnu-make and gnu-sed are all utility software freely distributed by Free Software Foundation.

have been about 50 people constantly working on the OS and thousands creating applications. [5] These programmers' consistent enthusiasm about LINUX is the power that has pushed forward the continuous development of LINUX.

GNU Project

The GNU project is an ongoing effort of the Free Software Foundation (FSF), a not-for-profit corporation founded by Richard Stallman and several others in 1983, with the goal of spreading the use of free software. To help achieve this goal, they started the GNU project to create a complete, usable, freely redistributable software development environment, including both operating system and utilities. [9]

GNU stands for ``GNU's Not UNIX'', but it is a complete UNIX-compatible software system. In his GNU Manifesto [10] written at the beginning of the GNU project, Richard Stallman stated that they wanted to make all improvements to UNIX based on their experience with other operating systems. He gave his reason of writing GNU from both users and programmers perspectives:

For users:

“I consider that the golden rule requires that if I like a program I must share it with other people who like it. Software sellers want to divide the users and conquer them, making each user agree not to share with others. I refuse to break solidarity with other users in this way.....”

For programmers:

“Many programmers are unhappy about the commercialization of system software. It may enable them to make more money, but it requires them to feel in conflict with other programmers in general rather than feel as comrades. The fundamental act of friendship among programmers is the

sharing of programs; marketing arrangements now typically used essentially forbid programmers to treat others as friends. The purchaser of software must choose between friendship and obeying the law.....

“By working on and using GNU rather than proprietary programs, we can be hospitable to everyone and obey the law. In addition, GNU serves as an example to inspire and a banner to rally others to join us in sharing. This can give us a feeling of harmony which is impossible if we use software that is not free. For about half the programmers I talk to, this is an important happiness that money cannot replace.” [10]

In response to Richard Stallman’s summons, plenty of programmers have voluntarily contributed programs and work for the GNU project. From 1983 till now, hundreds of GNU version of UNIX utility programs have been available for free distribution and redistribution on the Internet. In Linus’ first announcement of LINUX, he mentioned the implementation of a few GNU utilities. Actually the utility software modules in today’s LINUX include many GNU versions. It is fair to say that without the GNU project, the LINUX system would not be as usable and fairly complete as it is today. [9]

Open Source Model

By examining the development processes of LINUX and the GNU project, we can find that they follow a similar pattern: copying, distribution, modification and redistribution of both software and source code are offered free to the public via the Internet. There are licenses that define and protect these activities, such as the GNU Public License (GPL), the BSD license, the X Consortium license and the Mozilla Public License. [20] An accurate label to this phenomenon - open source - was created in February 1998, in reaction to Netscape's announcement that it planned to give away the source of its browser. [12] Before that, these products were simply called ‘free software’ which might

cause confusion with the software that is free to use but not open source code to the public. It has been recognized that the availability of source code is the key point of the entire issue.

Though a new name, open source has a history that traces back to early UNIX years, from BSD UNIX to the GNU project, to the engineering development of Internet, and to LINUX. The basic idea behind open-source is to encourage independent peer review and modification so as to facilitate continuous evolutionary improvement of the software. Any software development process involves writing code, testing, debugging or modification, and more and more iterative testing and modification.

It is obvious that testing and debugging are an integral part of software development process. In the closed-source case, testing and debugging are all done by the software owners. The software owners don't release the software until it is proved to be stable by all the tests done internally. Testing and debugging always take much longer than writing the code. Even so, by the time the real users run the software, they may still encounter problems not detected by the professional testers, because it is almost impossible for the testers to simulate all the situations in which the software will be used in real life. So without access to source code, when users have any problems with the software, they can do nothing but to report to the software owner. Whether the problems can be solved at all or in which manner is totally up to the software owner, which is beyond the control of the users.

In the open-source case, the source information is shared among both developers and users. So testing and modifications are not confined to a group of programmers as in the closed-source scenario. Every user can be a tester and some capable users can also do some debugging. This enables the original developers to release the software whenever it is written and let the users be part of the development process. The division between the developers and users are sometimes blurry, because users are all potential testers, debuggers or even co-developers. As a result, the software develops at a speed that is unimaginable by the conventional closed process. This fast evolution pushes the commercial vendors to make their products even better, otherwise they will be automatically excluded from the competition.

Besides rapid development speed, the open source model also means increased security and reliability, because the code under public view is exposed to extreme scrutiny, with the problems being found and fixed instead of being kept secret until the wrong person discovers them. [11]

Not only does the open-source model make better quality software than closed-source does, but it also benefits people learning to program. Finding out how others, especially masters, write code is an excellent way to learn a computer language. A computer language is no different than human language. Good writers all start with being readers of masterpieces. This is not to say that good readers can easily end up to be good writers, since it takes a lot more factors such as personal interests, intelligence, practice, and

dedication. Being able to read source code can give users the possibility to both learn from and control the software they choose to use.

It is obvious that open source model is an idealized approach to software development. The original developers, users and co-developers form a kind of online community based on mutual interest. This community emphasizes collaboration and interest sharing among the members. People in the community voluntarily give away their energy, time and innovative solutions to others without any direct material incentives or rewards. Then what are the incentives and rewards to the community members?

Mechanism of Open Source Community

To make sense of the open-source community, we cannot miss the part of how the community started in the very beginning. As introduced earlier, the open source model started with Bell Labs sharing UNIX source code with UC-Berkeley. It formed a win-win collaboration between both sides of the coalition. Bell Labs were not only interested in testing their original design, but they also realized that talents and creativity are an important part of software development, and universities are talent pools with low overhead. The university scholars with a passion for scientific excellence were also thrilled at being able to study such an exceptional design. The mutual interest in continuously improving the software and nature of scientific pursuit determined that it was in the benefits of each party to share information and keep communication open among everyone involved.

Later as computer networks began to grow, more and more open-source communities were formed via networks. Most communities used USENET newsgroups as a means of communication. Before the Internet had worldwide reachability, the networks were geographically separated. Participation in the communities was limited to computer professionals. Although different communities had different customs, they almost all followed the similar pattern: voluntary contribution of individuals' talents, time and creativity without direct monetary rewards.

Raymond argued that the ultimate drive and reward for this behavior is the desire for good reputation among one's peers. [13] His argument is basically based on the following three points:

- Human beings have an innate drive to compete for social status, which is wired in by our evolutionary history;
- In populations that do not have significant material-scarcity problems with survival goods, there arises gift cultures which are adaptations to abundance. In gift cultures, social status is determined not by what you control but by what you give away;
- The open-source community has in fact a gift culture. Almost none of programmers who have contributed to open-source software have any survival problem.

Therefore, in open-source community, the only available measure of competitive success is reputation among one's peers, which is represented by how much you can give away.

Meanwhile, Raymond also admitted that pure artistic satisfaction of designing beautiful software and making it work – craftsmanship - can be the primary motivation. Other

motivations may be honor, ethical integrity, self-esteem, or pride of accomplishment, etc. But all of these including craftsmanship culture are ultimately shaped by reputation incentives, which is actually rooted in ego satisfaction or self promotion. He also pointed out that the ego-based motivations are somewhat unconscious rather than conscious ideology. [13]

Although the various open-source communities share a similar mechanism, they are different in terms of character, scale and dynamics. Some ended up very successful, some not. LINUX is universally considered as a successful model of all the open-source communities. While it shares some of the features that are common in open-source communities in general, it also has its own particularity.

Reflections on the LINUX Community

LINUX was designed after UNIX and it was not the first open-source software. It started when open-source development practices had been around for at least a decade. But it was the first project to use the entire world as its talent pool. [15] It was also the first open-source project that worked at the kernel level.

It seemed like a coincidence that LINUX came at a time of the explosion of mainstream interest in the Internet. But to see the opportunity and make a conscious effort to take advantage of the emerging Internet involved a great vision. Linus perceived and took hold of the opportunity, and successfully made a giant leap forward in getting the open-source model known to the whole world.

While the Internet facilitated the growth of LINUX, it also made LINUX evolve at a scale unparalleled by any of its open-source predecessors. The LINUX kernel went to the public with a strong and attractive basic design, so it easily attracted the attention of the entire community. Modification and expansion of the original design once came so rapidly that a new kernel was released more than once a day! [15] This development intensity posed a great challenge to Linus in keeping the software integrated and consistent with the original design. It appeared that Linus demonstrated a powerful knack for leveraging the design talent of others. He did an impeccable job in recognizing good designs and integrating them into the LINUX kernel at an amazing speed.

By releasing rapidly, Linus successfully kept the contributors or co-developers constantly stimulated and rewarded. They were stimulated by the prospect of gaining peer respect, and rewarded by the sight of constant improvement of the system because of their work. [15] This was the key to retaining the interest of the whole community, which is much harder than getting the attention in the beginning.

Before LINUX, it was widely believed that the kernel development required much closer communication than the loosely connected online community could support. [10] It does make sense since the kernel is much more complex than the individual programs and entails flawless consistency. This makes the overall coordination an extremely demanding job. Linus was the first person who made it possible.

What is emphasized above are the factors that made LINUX distinguishable from all the other open-source communities. Being a member of the open-source society, it also shares the features that are common in that society, basically collaboration and voluntary support.

Commercialization of LINUX

Coming out of such a cooperative, open and technically oriented development environment, LINUX has proved to be a highly reliable and robust operating system. Naturally there are people who would like to invest in additional products and services and sell for profit on top of the original product. Linus himself had some comments on this trend in his keynote address at LINUXWorld:

"Some people have been seen as freeloaders, selling LINUX CDs and hardware and making money that way, But they're doing LINUX a big favor by making it easier to install and approachable to normal people. It makes it a more viable OS." [16]

John Ousterhout, the creator of the open-source language TCL, made it clearer why commercialization is crucial for the open-source software to be accepted by the mainstream users. He pointed out that most open-source projects start out with a single programmer solving a personal problem and making the solution available to others. The early adopters of an open-source package tend to be like the creator: sophisticated programmers with a particular problem that the open-source package solves. These people can tolerate the lack of documentation or support, and they are happy to help improve the package so that it better meets their needs. As the user community for an open-source package grows, it eventually becomes dominated by mainstream users who are often not sophisticated programmers and thus need more documentation and technical

support than the raw open-source package supplies. A widening gap develops between the needs of the user community and the features provided by the core developers, who are unlikely to fill the gap since their real interest are programming rather than any value-added features. Eventually, commercial ventures are needed to fill the gap and they are willing to do so because of the business opportunities made possible by the user demands. [19]

We have seen this happen in many open-source software systems including LINUX. It is obvious that commercialization has helped promote LINUX and made it move from obscurity to today's media focus. Recently we have seen more support from commercial vendors who are interested in porting their software to LINUX.

While some people see the scenario as giving LINUX much-needed credibility, a financial boost in the marketplace, and a potential to move LINUX forward to a broader, more mainstream scale, others worry that the cooperative community atmosphere for which the LINUX operating system has been renowned will be diluted by commercial interests. Some are concerned that distributions may be configured in ways that require tools or support from specific vendors rather than a choice of vendors or the ad hoc support available via the Internet. Others have expressed concern that larger independent software vendors may port their software to a specific distribution and create a de facto standard among the handful of distributions. Still others fear that LINUX kernel might face a UNIX-like splintering. [16]

Methodology

The literature review has helped to make sense of the open-source phenomenon and the LINUX community. This study aimed to get the opinions of the users and contributors in the real world, and to find out if the public press represented the notion of ordinary community members. For this purpose, members of the LINUX community were asked their opinions on several issues.

The easiest way to reach the LINUX community is to use the same medium that has supported the community to grow – Internet newsgroups. Deja News is a Web site where one can read, search, participate in and subscribe to thousands of discussion forums, including Usenet newsgroups. It has a large collection of currently active LINUX newsgroups. A questionnaire was designed and posted to a subset of the newsgroups. A copy of the questionnaire is included in the Appendix.

The questionnaire focused on the following questions:

1. How and when people started to use LINUX?
2. How often the LINUX newsgroup is being used?
3. What is it about LINUX that people like most?
4. What is the one thing people wish to see improved?

5. What are the motivations and rewards for the people who have contributed their time and talents to the growth of the whole community?
6. What are the differences between LINUX and other open-source communities?
7. What are the most important factors in building and sustaining open source communities, based upon personal experience with LINUX?

The emphasis of the study was to get responses from both users and contributors. And what people would say was considered more important than how many people would respond. The plan was to post the questionnaire to one LINUX newsgroup at a time. The responses would be examined to determine whether a follow-up or another posting was necessary.

The questionnaire was posted to the newsgroup comp.os.LINUX.misc on March 10, 1999. The 'misc' newsgroup was chosen because it had a larger number of the messages than most other newsgroups. A deadline for the responses was set to March 31, 1999. Within a week of the posting, 5 responses were received and examined. It seemed that most of the respondents were users and participation from developers was not sufficient. In the following week, no more responses were received.

On March 24, 1999, two weeks after the first posting, it was decided that another posting was necessary to attract input from developers. Therefore, the same questionnaire was posted to another newsgroup, comp.os.LINUX.development.system. It was selected because the archived messages in this newsgroup seemed to be more related to kernel

building, though the total number of messages of this group is much lower than the 'misc' newsgroup. The deadline for the second posting was set to April 7, 1999. Again all the responses were received within a week of the posting. The difference was at this time, eleven people responded and some of them contributed to the development of some LINUX utility software modules.

Because replies from both of the expected user bases were received, additional postings were not made for other LINUX newsgroups.

newsgroup and eleven responses from 'development' newsgroup. The email addresses of these sixteen respondents indicate that they are from both Europe and North America. Half of them have made some modifications to the source (kernel or utilities) either for themselves or for distributions. The rest are general users.

The respondents' experience with LINUX ranges from one month to eight years. Eight of them have used it for three years or less. Five of them started at 1993/94 - the fast booming period of the Internet. Two of them stated that they started to use LINUX out of curiosity, another two respondents said figuring out how to use LINUX was part of their jobs.

As to the second question - usage of LINUX newsgroups, two respondents said they never posted questions nor answers to any LINUX newsgroup (apparently they didn't count their replies to the questionnaire for this study). All the rest of the respondents were either occasional or regular users of at least one newsgroup. Some of them read several LINUX newsgroups everyday and answer queries whenever they have the chance. The frequency of postings varies from a couple of messages per year to almost on a daily basis.

The question of what is the most attractive part of LINUX received a variety of answers.

Most of them focused on the following aspects:

- freedom of customization, configuration, and fixability because of open source
- choices of affordable hardware
- free to use
- high quality and stability
- running UNIX at home at an affordable price
- non-proprietary.

One person said:

“I like that it isn’t proprietary. I like not being locked into one company’s vision of what my computer ‘experience’ should be. I like the fact that in three years of using LINUX, it has never, not even once, crashed on me.”

Another person said that “It is the best system you can use if you want to learn more all the time.” Another expressed that what he liked most about LINUX was “the combination of open source and the fact that development is moving like hell.”

For the things that needed to be improved, opinions were expressed from a variety of perspectives. These included:

- general need for a better user interface
- standardization between different distributions
- more financial and documentation support from commercial software and hardware vendors
- more hardware compatibility
- stronger marketing campaigns

- technical details like code cleanups, better file sharing and clustering, easier module and peripheral support, and less delay in video driver availability.

One person commented:

“There are many things to improve, and I think that will remain so forever. The system will never reach the stage where you can tell ‘that’s it, nothing more to do’. New features will continue to be developed until the sun goes

As a matter of fact, the never-stop status is one of keys to sustaining the continuous growth of any open-source software.

To the question of motivations for contributing time and talents to the LINUX community, the answers included:

- fun or pure pleasure
- need to make things work or make it better

One person said:

“Programming is something I like to do and I do it anyway. To contribute the programs I make gives me one more nice feeling.”

Another gave his incentive as:

“It's a cool feeling to know that people are using your software because it's

Another observation was:

“Slow network connection. So it was easier to modify the source locally then to download the next release.”

As for the rewards of contribution, some answers are more craftsmanship oriented, such as:

- “It is nice to be able to say one’s job is one’s hobby too.”,
- “Fun! Learning a lot about operating system design.”
- "Got a working system." or "seeing the problem fixed."
- "The program does what I want it to do."

Others more or less revealed certain degree of ego satisfaction:

- “Perhaps a little peer recognition
- “The sense that I gave something to the community that gave me a free,
- “Personal satisfaction when I see that more than 20 people worldwide are actually using what I wrote. That is a great feeling.”
- “Our system turned out to be the master/server of the event. Just makes

When it came to the question of willingness of future contribution, the answers were unanimously positive. Some comments are:

- “We can't close the world and put gates everywhere.”
- “One can learn a lot and make use of it somewhere else and finally I've got a nice system so it is only fair to give something back.”

About the difference between LINUX and other open-source communities in terms of community dynamics, comments were not so unanimous. One person had the idea that the LINUX community was somewhat overzealous at times. Another commented:

"LINUX isn't that distinguished, though you could claim that it has had no apocalyptic schism, like gnu emacs, or gcc/egcs."

Other comments were more focused on the people and the community scale:

- "More openness and willingness to accept suggestions, quicker response times..."

- "LINUX has Linus....it seems like any such cooperative development venture evolves to be run by a cabal, and it's LINUX's luck that Linus is pretty decent."
- "People who work with LINUX seem to have a certain zeal, a love of what they do."
- "LINUX seems like a much more dynamic and widespread community."

The last question asked about the most important factors in building and sustaining open source communities. Some said it was the people:

- "A gifted leader for the project, smart and talented enough to know that even though he's bright he doesn't know everything and can't think of everything. "
- "Goodwill, knowledge, mind to share that knowledge, will to learn."
- "Change. Willingness to change."
- "People crazy enough to administrate/work on such projects."
- "Project leader"

One person thought it was the combination of the people and the communication facilities:

"The people. That involves setting the tone early on, probably, so that the right people wind up involved. Also, I believe you could make the case that the LINUX-sort of project could only exist on a thoroughly wired (at low latency) world. Most LINUX is due to email and email lists; a certain amount due to IRC, some due to face-to-face conferences, etc."

Two people made the case that it was the Internet:

- "Instant, world-wide methods of communication. It's no coincidence that LINUX and the World Wide Web grew up simultaneously."
- "Open source is a phenomenon of the internet. Sure it's existed for a while but look when it took off. It wouldn't have without the Internet."

Some others thought there were other factors:

- "You cannot build one, it builds itself. It grows out of a common interest of people all over the world. It can fail or it can work out. Sure, there is always someone or more than one person who have to have a kind of final word, else all would end in chaos, but given some mutual respect and it works pretty well."
- "The chance to overcome the MS monopoly has been an important factor. It **had** to be something and LINUX was the only real possibility."
- "Freedom is the most important factor - MY freedom to be able to influence the things I use, MY freedom to change what I don't like, MY freedom to do what I like to (without someone getting hurt)"
- "Software quality and knowledge."

There were also comments on other aspects of LINUX. Some respondents to the study stated that LINUX needs stronger promotion to make it known and accepted to the masses. This requires a better user interface. One respondent pointed out that the GNOME and KDE projects are two of the endeavors filling in the holes.

As for more market promotion, another respondent suggested that some tactics should be used:

"I think that the open source community needs to continue to be vocal in promoting their software, but they also need to avoid attacking (flaming) those who do not share their views. Rational arguments will be much more successful in winning converts, and fortunately this has been the case for the most part. The media is still pretty ignorant about what exactly LINUX is and polite but firm rebuttals will be the most successful way of turning the tide."

Summary and Conclusion

It seemed that all the people who have responded to the study are open-source supporters. One person even expressed the willingness of taking open source approach for his own project. He wrote:

“I'm working on several projects right now, most of them are work related. Probably I'll make them open source after I finish (the goal of my work is the results of the running the software, software development is just the means of achieving it).”

Actually more and more people have realized the importance of open source to the continuous improvement of the software. Even Microsoft, a company known for fiercely protecting its intellectual secrets, is "seriously considering" opening the source code of the Windows NT kernel to allow outside programmers to improve on the technology, although the company may not follow through on the idea. [17]

All but one respondent listed some items that needed to be improved in LINUX. Someone mentioned that different distributions should follow some standard. Apparently this has been recognized since the LINUX Standard Base has recently been formed to remedy subtle differences among the distributions in non-kernel activity. As to the kernel, it is right now controlled by only one person - Linus. Linus and his core development team have shown great diligence in protecting the operating system kernel from a UNIX-like splintering. [16]

Actually many of the changes that the respondents wished to happen to LINUX are underway, for example:

- products with window-like user interface like GNOME and KDE have come out, though their stability is still a question;
- more support from commercial vendors including Intel, Compaq, Dell, Hewlett-Packard, IBM, and Oracle, who are jumping on the LINUX bandwagon in recent months. [16]

All of these are part of the impetus that help LINUX get mainstream acceptance.

As for the motivations and rewards for the voluntary contributions, the responses were along the lines of what had been found in the literature. Although there were variations of words used, the basic idea was fun and pleasure of craftsmanship. Some people even mentioned personal satisfaction.

For the questions of differences between LINUX and other open source communities, as well as the most important factors in building and sustaining open source communities, responses focused on the people, especially the project leader, and the communication facilities. It was interesting that nobody specifically mentioned the quality of the software as a crucial factor. According to Linus, the good design principle of the original kernel of LINUX formed a foundation that made it easier for others to contribute to the expansion. LINUX, as well as many successful open-source projects, have a modular architecture. The modules allow users to extend the system's functionality independently while the

core kernel can remain manageable. [21] That was indispensable in making LINUX the first operating system developed by a loosely knit community rather than a closely connected team.

It is also worth mentioning that the open source model is not a panacea for any software products. Tim O'Reilly pointed out that a marginal product with little market acceptance is impossible to be turned into a star using open source as some kind of magic bullet. [20] It seems that the respondents to the study took it for granted that the original software in the open-source environment had to have the ability to attract common interest.

LINUX is a project that has a proud history of rapid development with a wide developing base involving both voluntary and commercial developers. It is still growing at a scale that is unmatched by other open-source products. According to Linus, the most exciting developments for LINUX will happen in user space rather than the kernel space. [21] It will be interesting to see that in the near future, LINUX will become a serious alternative operating system for both individual end users and mainstream corporations.

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Appendix

Posting to newsgroup comp.os.LINUX.misc on March 10, 1999

Dear Linux users and developers,

I am a master's student in the School of Information Library Science at the University of North Carolina at Chapel Hill. I have been deeply amazed by how Linux has thrived in the hands of so many loosely knit voluntary developers all over the world. For my master's paper I am studying the dynamics of the Linux community, especially what made Linux so distinguished among all the open source software systems.

I would very much appreciate your time to answer the following questions and email them back to me before March 31, 1999. Your participation is completely voluntary. All responses will remain confidential, and care will be taken in the final paper to assure that no respondent will be identified.

Questions:

1. How and when did you start to use Linux?
2. Have you ever used any Linux newsgroup to ask for help or give help to others? If so, how often?
3. What is it about Linux you like most?
4. What is the one thing you would like to see improved or added?
5. Have you contributed to the development of Linux by writing or modifying its source code? If yes, please answer 5.1-5.3.

- 5.1 What motivated you to spend your time and talents to make this contribution?
- 5.2 What do you think are the rewards of your contributions?
- 5.3 Will you contribute to it in the future? Why?
- 6. If you have contributed to the development of other open source software, have you noticed any differences between Linux and other systems in terms of the dynamics of the developer community? If so, what are they?
- 7. Based upon your experience with Linux, what do you think are the most important factors in building and sustaining open source communities?

If you have any questions about my master's project, please feel free to email back to me at zhaoh@ils.unc.edu, or to my advisor, Dr. Gary Marchionini, at march@ils.unc.edu.

Thank you very much for your time and assistance.

Zhao, Hui Heather
School of Information and Library Science
University of North Carolina at Chapel Hill

Posting to newsgroup comp.os.LINUX.development.system on March 24, 1999

Dear Linux users and developers,

I am a master's student in the School of Information Library Science at the University of North Carolina at Chapel Hill. I have been deeply amazed by how Linux has thrived in the hands of so many loosely knit voluntary developers all over the world. For my master's paper I am studying the dynamics of the Linux community, especially what made Linux so distinguished among all the open source software systems.

I would very much appreciate your time to answer the following questions and email them back to me before April 7, 1999. Your participation is completely voluntary. All responses will remain confidential, and care will be taken in the final paper to assure that no respondent will be identified.

Questions:

7. How and when did you start to use Linux?
8. Have you ever used any Linux newsgroup to ask for help or give help to others? If so, how often?
9. What is it about Linux you like most?
10. What is the one thing you would like to see improved or added?
11. Have you contributed to the development of Linux by writing or modifying its source code? If yes, please answer 5.1-5.3.
 - 5.1 What motivated you to spend your time and talents to make this contribution?

5.2 What do you think are the rewards of your contributions?

5.3 Will you contribute to it in the future? Why?

12. If you have contributed to the development of other open source software, have you noticed any differences between Linux and other systems in terms of the dynamics of the developer community? If so, what are they?

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If you have any questions about my master's project, please feel free to email back to me at zhaoh@ils.unc.edu, or to my advisor, Dr. Gary Marchionini, at march@ils.unc.edu.

Thank you very much for your time and assistance.

Zhao, Hui Heather

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