A Preliminary Investigation of the Impact of Open Source Software on Telecommunication Software Development

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***Abstract*— Open Source Software (OSS) adoption has increased significantly over the past decade. Its importance is evidenced by the extent to which it has been embraced by companies such as IBM, HP and Novell. The influence that this trend is likely to have on large corporations warrants an a full investigation. This paper begins that process, the focus being primarily on the current and projected impact of OSS on the telecommunication industry. Various telecommunication-specific OSS projects are discussed. In particular, the paper explores the possible effects that the adoption of OSS may have on current software development approaches. These preliminary investigations point to the need for a much wider one. The goals for such a more detailed study are identified.**

***Index Terms*— Open Source Software, Software Development, Telecommunications, Corporate Adoption.**

I. Introduction

A preliminary survey into *the effects of open source software (OSS) on software development within telecommunication companies* is given in this paper. It draws together information from a variety of literature sources, as well as from an acquaintance with current OSS usage. The paper begins by sketching a number of developments that confirm OSS to be a phenomenon of major significance in both the general IT context as well as in the telecommunications sector (Section II). In Section III tentative definitions and distinguishing features of OSS are briefly surveyed. Section IV categorises the different possible levels of engagement in OSS development and usage, as practised by various agencies. Reasons why OSS is particularly important to developing countries, are adduced in Section V. This section also summarises the important recent OSS initiatives that have been undertaken by the South African government. Section VI outlines several typical software development activities commonly encountered in the telecommunication industry. *Prima facie* evidence suggests that OSS could be beneficially deployed in these contexts. In Section VII a number of important observations are made about the range, scope and impact of current OSS use in key ICT domains related to telecommunications such as the Internet. Collectively, the information provided suggests that there is a critical strategic need for a more intensive investigation into OSS in relation to telecommunication providers. The goals of a such an investigation are identified in Section VIII and concluding remarks are made in Section IX.

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II. The OSS Phenomenon

Over the past decade the ever-increasing pursuit of open source software (OSS) has sent shock-waves throughout the IT industry. Some observers are inclined to characterise the attempts to inject OSS into the industrial market as a battle between the mighty commercial software sector and a small group of naïve and idealistic hackers. The implication is that the hackers are bound to loose out in the long run. However, it should be borne in mind that OSS provided – and indeed still provides – not only the software upon which the Internet is built, but many other software products that are in routine strategic use in a variety of contexts. One could hardly imagine that the Internet would have evolved without Apache, Sendmail and BIND. Similarly, the widespread use of Linux in switches, servers and workstations is well known. In addition, numerous software developers rely on a wide array of OSS development tools to enhance their productivity. These examples strongly suggest that OSS is more than a mere flash in the pan and that it needs to be taken seriously.

As in so many other industries, the ripples caused by OSS have also been felt in the telecommunication industry – specifically in the industry's IT support area. One consequence of this has been an investigation into the effect of OSS on the telecommunication industry conducted by the *European Institute for Research and Strategic Studies in Telecommunications* (EURESCOM). The resulting report [7] provides an analysis on the effect that OSS is likely to have on the telecommunication industry.

As the gap between information technology and the traditional telecommunication industries has narrowed, so the notion of using open source software (OSS) in telecommunication industries has gained momentum. The initiation of several OSS projects that are directly targeted at the telecommunications' core business areas confirm this trend. Examples include the VOCAL project from the Vovida group [2] and the

SIPfoundry [1] initiative launched at the Spring 2004 Voice On the Net (VON) Conference and Expo.

Another project of importance to the telecommunication industry is the development of a Carrier Grade Linux by the Open Source Development Labs (OSDL). See [12] for a more detailed discussion of this project. Clearly, therefore, OSS is a major phenomenon to have entered the ICT industry, and all sectors of this industry would do well to take stock of its impact.

III. Defining OSS

Notwithstanding this widespread incursion of OSS into the ICT industry, trying to define OSS turns out not to be quite as easy as one might think. The Google summary (See [10]) of definitions on the web for "Open Source" is broad and relies heavily on the rather naïve definition of OSS as 'software where the source code is available for anyone to extend or modify'. Should one turn to the Open Source Initiative (OSI) as the principle OSS authority, the OSS definition turns out to be much more complex and intricate (See [18]). At the time of writing, the 1.9^{th} version of an OSS definition had been formulated, clearly suggesting that people have been grappling to converge to a universally acceptable definition. This current definition is too extensive to be reproduced here and its full explanation is beyond the scope of this paper. Nevertheless, some of the elements addressed by the definition are worth mentioning. These include: the free ('as in freedom') distribution of software; the availability of source code; the legality of derived works; the non-discrimination of usage; and the non-restrictiveness of a license.

A list of licenses that comply with the OSI's definition of OSS can be found at [17].

The OSI's OSS initiative should not be confused with the Free Software initiative, promoted by the Free Software Foundation (FSF) [9]. To some extent, these approaches are similar. However, the FSF focuses on the inviolate freedom of using their software, whereas the OSS community's goal is to ensure that the source code is always available, but is more tolerant about its application.

IV. Levels of OSS Engagement

The extent to which people engage in the production and use of OSS ranges from simple usage of an OSS product to full engagement in driving an OSS project. Different levels of OSS engagement are briefly described in the subsections below, starting off with the least involvement, in Subsection IV-A, and progressing to Subsection IV-D which discusses the management of an entire OSS project. Although certain benefits are associated with each of these engagement levels, each level also requires certain resource commitments. These will be indicated in the discussion to follow.

A. Simply using a product

At this level one simply acquires the OSS product in either source or binary form and uses it to fulfil a need. In most cases this requires a negligible expenditure of resources. As a matter of courtesy, one may register as a user of the product, but this is merely to indicate one's support for the product.

The primary benefit of engaging OSS at this level, is the low investment required to acquire software solutions that address one's need.

It should be noted that commercial support services for various OSS products are sometimes available, either through the project sponsors or through third parties. The Linux distributions such as Red Hat and SUSE are examples of OSS that is backed up by commercial support services. Thus, arguments sometimes made by proprietary software vendors, that the use of OSS leaves the user without any support, should be treated as generalisations rather than as universal truths.

This level of OSS engagement – simply making use of an OSS product – is not regarded as negative within the OSS community. On the contrary, the community's view is that someone simply using an OSS product may in fact use it to develop some other OSS product. For example one may 'simply use' the Linux kernel but contribute to the development of Mozilla, as a result of which the kernel developers may eventually reap certain benefits as well. In theory, this means that all community members benefit in a 'balanced' way.

B. Modifying a product without sharing the modifications

At this level of OSS engagement, one may decide to take an OSS product and customise it to suite one's specific needs. These changes may then be kept internally instead of sharing them with the community. There are a diverse set of reasons why one might keep the changes to oneself. For example, it might be that the modifications include royalty and/or patent regulated elements.

At this level, the degree of resource investment increases in proportion to the extent of internally made modifications to the original OSS product.

C. Modifying a product and contributing the changes back into the community

Here one acquires the product and again makes changes and/or fixes problems to suite one's particular need. However, arrangements are then made to integrate these changes back into the original project or to make the changes available to the community in some other way. The resource expenditure at this level of OSS engagement will also vary in proportion to the extent of the contribution.

D. Initiating and/or managing an OSS project

Usually, at this level, significant resources will have to be invested into an OSS project. Participation at this level usually becomes necessary when no one else is willing or able to address a need and/or when one is the leader in the project's solution domain. The most noteworthy benefit is the ability to steer (at least to some extent) the direction of the project.

Examples of this level of engagement include Netscape's initiative in undertaking the Mozilla project and Pingtel's initiative with SIPfoundry.

V. Africa

Viewed from a developing country's perspective, there appears to be a number of particular benefits associated with the adoption of OSS strategies and policies. Three hoped-for benefits are listed here:

- Since licencing fees are no longer payable OSS adoption results in a reduction in expenditure on imported software from developed countries. It is sobering to note that estimates of the South African government's annual expenditure on proprietary software licence fees is over 3 billion rand [13] – enough to cover the annual running costs of several tertiary institutions!
- It has just been noted that the barrier to entry into ICT (both use and development) is high, especially due to the high costs of proprietary software. It has also been noted that OSS has the potential of reducing this. This means that OSS can potentially help developing countries to bridge the digital divide and join the information age.
- The successful wide scale deployment of OSS could not take place without a commitment by the state to upgrade IT skills in support of such adoption. As a result, in order to be successful, large scale OSS adoption would have to carry in its wake a significant and beneficial investment in IT skills development.

In order to encourage the adoption of OSS in Africa, the Free Software and Open Source Foundation for Africa (FOSSFA) has been formed with the support of African leaders. FOSSFA's report and action plan is provided in [8].

In 2001, the South African National Advisory Council on Innovation (NACI) held a workshop to promote the use of OSS in South Africa. The workshop produced a discussion document [14] that was released for public review. Feedback was used to update the document, which was subsequently presented to the Cabinet. Cabinet subsequently approved further investigation into OSS, as a result of which the South African Government launched, in September 2002, a drive towards gaining an understanding of OSS and its strategic impact on government. The initiative included the launching of a website (`www.oss.gov.za`) to facilitate the debate in public, as well as the publication of a report [11] compiled by the Government Information Officers' Council (GITOC). The report highlights the strategic importance of OSS to government. Also included in the report are proposals on how the government might adopt OSS and promote OSS in South Africa.

In addition, the Council for Scientific and Industrial Research (CSIR) has created the Open Source Centre (OSC) to assist both government and industry with OSS initiatives through training, awareness and support initiatives.

These initiatives testify to the fact that the South African government places a high premium on OSS. Many state bodies are currently engaged in investigating and supporting its OSS initiatives, including: NACI; GITOC; the Presidential International Advisory Council on Information Society and Development (PIAC on ISAD); the Presidential National Commission on Information Society and Development (PNC on ISAD); the National e-Strategy Task Team; the CSIR; and the State Information Technology Agency (SITA).

VI. Telecommunication Provider Software Development

Telecommunication providers clearly tend to have similar software needs and tend to follow similar practices in fulfilling these needs. They generally engage in a wide range of software development projects, not only related to core business processes but also related to supporting business processes. We briefly review here, some software development needs typically associated with telecommunication providers, without wishing to imply that these are limited to the telecommunication industry, nor that the review is complete.

Examples of supporting business systems include payroll-systems, human-resource management systems, accounting solutions, etc. Core business software may include network-planning solutions, network-management, operational support systems (OSS), next generation network (NGN) applications and VoIP solutions.

One of the software development tasks traditionally performed by telecommunication software developers is the integration of multiple third party solutions to meet the network provider's overall need. For example it might be necessary to connect the payroll system from vendor A with the accounting package of vendor B. Should the propriety solutions of vendors A and B be provided in binary-only format, then the integration effort is likely to be more complex and tedious than if the source code of the different packages had been available. If the documentation or Application Programmer Interface (API) for the propriety solutions is limited, it may well become necessary to bring in consultants or vendor representatives. This increases the cost and time associated with a project. Clearly, there could be advantages in relying on OSS in these contexts.

Another type of software development activity frequently undertaken by a telecommunication provider is what may be termed a proof-of-concept project. Here, the feasibility of a larger project is investigated by 'gluing' or hacking together existing products, possibly extending them in some way, in order to solve a problem – or at least demonstrate that the problem can be solved in principle. The project pace is fast and is aimed at producing nothing more than a prototype. Hence, in building the prototype, there is little incentive to rely on products that require a financial investment. OSS products seem to be ideally suited for this type of development, not only because of their low procurement cost, but also because of the availability of source code.

It is a common cause that wherever significant software development takes place, – including within the telecommunications industry – some developer is likely to acquire and start using an OSS tool to assist in that development. The range of available OSS tools covers a wide spectrum, including editors, documenting systems, versioning systems, modeling tools, integrated development environments, compilers, code generation systems,build and install systems, testing tools,

bugging and issue tracking tools, Blogs[1], etc. Furthermore, Robbins [16] notes that such acquisition tends to have a cumulative character so that, over time, the software development team begins to rely more and more on these OSS tools. Prudence demands that this acquisition process be appropriately managed, and guidelines for doing this are provided by Zwartjes *et al.* in [19].

The forgoing discussion points to a number of activities that are likely to take place as part the commonly undertaken software development projects that are typically needed in the telecommunications provider context. They suggest that a variety of forces will increasingly apply pressure in the direction of OSS adoption. Section VII reviews a number of additional instances in which OSS adoption has already had a major impact on the telecommunications industry, as well as on the ICT industry as a whole. Such OSS adoption is likely to impact on the software development approach.

The effect on the software development approach when adopting a OSS strategy is elaborated on towards the end of Section VII. These findings represent preliminary input into in a much wider study that is currently underway. The scope and goals of this wider study are briefly outlined in Section VIII.

VII. Major OSS Trends

In this section, a brief assessment is made of the impact that OSS has been making in selected areas of the ICT industry. Clearly, this is not intended as a comprehensive assessment. It should rather be seen as the outcome of a pilot investigation into the OSS phenomenon, providing a justification for a much more intensive study.

The Internet is an example of a data network that is primarily built on OSS solutions. For example, Apache holds over 66% of the web-server market [15]. The majority of domain name servers (DNS) are BIND. QMail and Sendmail together dominate the SMTP Server market [3]. In addition, the leading web-based e-mail clients such as SquirrelMail and IMAP webMail Program (IMP) are OSS solutions. Indeed, Telkom SA itself uses SquirrelMail as its ISP business' webmail client. Even the operating systems such as Linux and BSD that are commonly used for these servers are OSS based. In the case of business supporting software, various OSS solutions are regarded by many people as viable alternatives to their proprietary counterparts. Examples include OpenOffice; Ximian Evolution; Mozilla; Linux (in a multitude of distribution flavours) and MySQL. In fact, Evans Data Corporation's December 2003 database survey shows a 30% increase in the use of MySQL [4] .

As the voice and data networks converge ever closer, OSS products appear to be playing a major role in bringing this about. Because of OSS projects such as VOCAL by Vovida, and the sipX range by the SIPfoundry, the provision of VoIP solutions in Open Source form has become a reality. These projects are backed by industry leaders such as Cisco, which is one of the sponsors of VOCAL.

This convergence highlights the need for telecommunication providers to adopt OSS solutions in building the backbone of a data oriented network. This may be deduced by the aforementioned importance of OSS in the current internet backbone.

The growth and success of Linux as the major OSS operating systems, has brought to the fore, the need to adapt it for telecommunication usage. As a result, OSDL has launched the Carrier Grade Linux (CGL) initiative. The goal of this project is to develop a Linux derivative that meets the availability and service needs of telecommunication providers. This initiative has drawn considerable attention, to the extent that a third version of the specification has been drawn up. The project could hold both positive and negative implications for existing telecommunication providers. In a positive sense, it could mean that lower capital investments will be needed for adopting NGN solutions. On the other hand, the very fact of its low cost could generate additional competition for existing telecommunication providers, since the current entry barrier caused by huge capital investment requirements will be lowered. In addition, such a new entrant into the market would not be encumbered with an existing expensive capital investment base that needs to be serviced. This foreshadows a potential scenario similar that which arose when Japan's third operator entered the market. The latter started from scratch with a soft-switch solution for its network, thus allowed it to provide services at a lower cost that the existing operators.

Several large corporations have started adopting an OSS approach over the past number of years. Companies of stature such as IBM, Novell and Hewlett-Packard (HP) are among these. Hewlett-Packard has even developed and adopted the *Progressive Open Source* [5] strategy. This strategy defines three levels of open source software development within HP, which may be summarised as follows:

- *Inner Source*. This designates the use of an Open Source approach within the company when developing certain products. The visibility of these products is restricted to the internals of the company.
- *Controlled Source*. A project classified as such is restricted not simply to the company itself, but also to selected partners outside the company.
- *Open Source*. This designates a normal OSS project as defined by the OSI.

This approach could be adopted by any large company, thereby both benefiting from and adding benefit to the OSS approach, within the constraints of certain business/legal limitations. With this approach one would be able share code/artifacts between business units – in the case of *Inner Source* – reducing duplication as one benefit. Between business-partners that partake in the same industry with similar needs, the co-operation could extend the relationships and potentially benefit all parties involved by sharing development cost for example.

The increased adoption and interest of OSS has lead to Microsoft introducing its *Shared Code* initiative as a counter to the shift from proprietary to OSS solutions. The implications of this initiative need further investigation.

[1] **'Blog** – (weB LOG): A blog is basically a journal that is available on the web. The activity of updating a blog is "blogging" and someone who keeps a blog is a "blogger". Blogs are typically updated daily using software that allows people with little or no technical background to update and maintain the blog. ' [6]

In considering the traditional in-house development versus OSS development, some preliminary observations about the differences in the respective approaches to software development can be inferred.

Firstly, the features of an OSS project are typically driven by the contributors' immediate needs, whereas traditional projects tend to compile/plan requirements in detail before starting development.

Secondly, the primary focus lies with the source code and, as a result, most effort typically goes into producing the code. This means that an OSS approach tends to limit the 'burden' imposed by documentation and modeling, keeping these activities to the bare minimum. Traditional development approaches, by way of contrast, tend to generate a larger amount of documentation and models.

Thirdly, OSS projects are driven by volunteers who are motivated by a need for the solution that is to be delivered. This motivation is extended to include an interest in domain and/or technology associated with the project. Within a company this may not be the case since an employee is assigned to projects as the manager sees fit. This tends to limit the personal motivation of the employed developer.

These, and a number of other factors are described by Robbins in [16]. These factors and their effects on the software development approach of corporate development teams that are considering adopting OSS, need to be investigated further.

VIII. Goals of the Investigation

The previous sections provide *prima facie* evidence that an in-depth investigation into the potential role and impact of OSS on South African telecommunication providers, is a matter of strategic importance.

Such an investigation is currently being undertaken, and the following goals have been identified:

- An initial objective is to gain an understanding of what OSS is, what its history is and what its possible future may be. The information provided in Section III represents initial findings relating to this objective.
- A second objective is to critically investigate the alleged motivations for developing OSS solutions. It is important to identify the critical success factors for relying on OSS solutions.
- In support of the previous objective, it is important to investigate what appears to be an emerging trend in terms of which certain large corporations have started or have acquired OSS businesses. A prime example of this phenomenon is the fact that Novell has bought SUSE and Ximian. There is a need to study the effect that this trend may have on the OSS movement as a whole.
- It is also important to establish how OSS products compare to propriety solutions. This should include an examination of metrics relating to quality, usability, maintainability, return-on-investment (ROI) and total cost of ownership (TCO). The fact that there has not been a lemming-like rush to acquire OSS across all sectors of the IT community, despite its free availability, indicates that there are a host of metrics, both other explicit and implicit, that are deployed in deciding on where and when OSS should be used.
- Further investigation is necessary into the viability of adopting OSS alternatives in specific support of business solutions. For example, under what circumstances would it be viable to replace proprietary operating systems, office suites, databases, etc. with OSS systems?
- There is also a need to explore the range and usability of OSS solutions that are specifically focused on telecommunication needs.
- Another objective is to resolve the legal aspects associated with the diverse range of available OSS licenses, many of which are currently in use.
- Different models of engagement with OSS projects have been mentioned in Section IV. How these various levels of engagement influence in-house software development needs to be more fully explored.
- There is a need to critically investigate the differences between traditional software development approaches and those typically used in OSS projects. Many questions come up in this regard. In practice, are there indeed significant differences between the two domains? What are these differences in practice? What – if any – differences should there be?
- An important objective is to compile a model that will provide guidance on the use of OSS solutions. Although the model will primarily be directed at a telecommunication provider's in-house development team, it is likely that it will be more widely applicable.

IX. Conclusion

Open Source Software is a significant phenomenon that is increasingly successful in areas such as internet infrastructure, client and server platforms and software development tools. In the telecommunications industry, it is making inroads into IT support, software development and even the core business of designing, operating and managing telecommunications networks. However, decisions concerning when and where to make use of OSS are being made largely within tactical contexts, and without appropriate information about their potential strategic effects. This article puts forward an argument showing that it is strategically important to undertake further investigation of the effects that the adoption of OSS products and development philosophies might have, with a specific focus on the telecommunications industry.

Starting with an introduction to the concepts underlying OSS, including the levels of possible engagement, the article goes on to explain why and how OSS is important to developing countries. Among the reasons are reduced licencing fees, reduced barriers to entry into ICT industries, and possibilities of local skills development. Africa is embracing the OSS concept, with a few major initiatives gaining impetus. In South Africa, in particular, there is significant government interest and support for the promise that OSS holds in nurturing a budding local ICT industry and narrowing the digital divide.

Focusing in on the telecommunications industry, the article discusses how OSS may be beneficial to software devel-

opment efforts in that industry. In the two primary areas of software development, supporting business systems and core telecommunication systems, the activities of integration and developing proofs of concept are expected to benefit from the adoption of OSS products, including useful software development tools.

Looking further, the article shows how OSS is beginning to have an effect on many ICT aspects of the telecommunications domain. Convergence of data and voice networks, combined with the possibilities of lower barriers to entry with OSS solutions, have seen the start of significant efforts such as enhancements to Linux in order to provide the quality of service demanded by telecommunications. OSS alternatives for office communication and productivity tools, desktop and server platforms and databases are being investigated earnestly in the continuous search for cost effectiveness. Large companies are adopting some of the principles of Open Source development in their software development, to harness wider creative power and potential numbers of willing participants in projects, company-wide.

Faced with compelling change, we often resort to intuitive responses rather than well-founded reasons. There is therefore a need, especially in South Africa, for critical analysis of the implications of these changes. For this reason, investigation should be undertaken into important aspects of OSS: the future, risks and benefits, motivation and success factors, and comparing OSS to proprietary offerings in terms of quality, usability, maintainability, return on investment and total cost of ownership. The viability and recommended process of replacing proprietary products with OSS alternatives, the range of products focused on telecommunication needs in particular, and the influence that OSS development will have on in-house development, are further pressing areas of investigation. These investigations should be synthesised into a model that will guide involvement with, and deployment of, OSS. Initially, the model should be directed at telecommunication providers' in-house development teams, but wider applicability should follow.

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