UNITED NATIONS

TD

United Nations Conference on Trade and Development

Distr.
GENERAL

TD/B/COM.3/EM.21/2
17 August 2004

Original: ENGLISH

TRADE AND DEVELOPMENT BOARD
Commission on Enterprise, Business Facilitation and Development
Expert Meeting on Free and Open Source Software:
Policy and Development Implications
Geneva, 22–24 September 2004
Item 3 of the provisional agenda

FREE AND OPEN SOURCE SOFTWARE: POLICY AND DEVELOPMENT IMPLICATIONS

Background paper by the UNCTAD secretariat*

Executive summary

Free and open source software (FOSS) has become an inseparable component of the global technological ecosystem as well as of the current debate on information technology and development policy. Much of the Internet and a distinguished list of technology businesses use FOSS-based infrastructures for mission-critical tasks. Nevertheless, FOSS is often insufficiently understood from an economic, human capacity and intellectual property perspective, issues with important development implications. Given a greater awareness and better understanding of FOSS, Governments may need to adjust their policies, primarily through their e-strategy. The notion that FOSS can have positive externalities makes it an important consideration in countries with strong development agendas. FOSS has substantial potential for business and commercial use, and for-profit entities may benefit from exploring FOSS-based solutions. FOSS has triggered thinking on and consideration of issues relating to content provision and consumption in other areas of human activity such as education, science and creative endeavours, where its contribution is making available a spectrum of solutions for creative work, research and development and knowledge distribution, in between the proprietary model and the public domain.

* The publication of this document has been delayed because of the need to consider the outcome of UNCTAD XI.

Abbreviations

CD	compact disc
FOSS	free and open source software
FSF	Free Software Foundation
GNU	Gnu is not Unix
GPL	General Public License
html	HyperText Markup Language
ICT	information and communication technologies
IP	intellectual property
IPR	intellectual property regulation
IT	information technology
OSD	Open Source Definition
R&D	research and development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Contents

1. Introduction

1. Free and open source software (FOSS) is brought up, with increasing frequency, in discussions about digital technologies and economic development, in particular with regard to strategies for capacity building for information and communication technologies (ICT), the Internet and e-commerce, in developing and transition economy countries. The UNCTAD *E-commerce and Development Report 2003* discussed the FOSS issues in some detail.[1] The UNCTAD FOSS web page provides links to analysis relevant to policy makers and includes descriptions of selected FOSS activities that are also included in this paper as annex I.[2] On 26 February 2003, the UNCTAD Commission on Enterprise, Business Facilitation and Development at its seventh session took the initiative, during consideration of item 5, theme 2, in exploring basic concerns. Lastly, the World Summit on the Information Society had no fewer than seven separate events dedicated to FOSS issues during its first phase, held in December 2003.[3]

2. Software is an important component in the digital technology equation. But it is much more than that. At a personal level, it is the interface between humans and hardware that speaks the binary language of ones and zeros. For technology to be useful, it needs to perform in a human-accessible way: this is achieved though software. At the level of society it is a set of rules, protocols and conventions that govern access to, and management, control and exchange of, data and knowledge. Software governs these at a technical level. However, each and every program we use and the data it accesses comes with implied or explicit contracts of rights, restrictions and compensation. Therefore, software governs our digital access at an economic, social and political level as well. Thus public policy on software, which is characterized not only the latter's technology or function but also by the social, economic and legal conventions it carries, becomes a development and governance issue.

3. FOSS challenges our preconceptions about how software is used, produced and distributed and the associated rights and responsibilities. It questions our perception of the global proprietary software industries and proposes possible alternatives to the ubiquitous programs they produce. FOSS discussions almost inevitably ask what could motivate highly qualified computer experts to devote their time to developing software that they seemingly give away for free. They may consider how FOSS fits into the international intellectual property debate and regime. They often open a debate about appropriate government policy: should the State legislate, invest in, or have a purchasing preference for FOSS? Can this enhance or does it decrease competitiveness in the ICT services industry? Does FOSS provide robust and scalable applications and qualified technical support needed for commerce? What are the effects of FOSS on other development issues, such as creative industries, education, science and health?

4. FOSS is very common. In fact, most people use it, at least indirectly, every day without realizing. It is a dominant force on the Internet. Indeed, more than half of Internet servers — computers that store websites and make them accessible — run on a FOSS operating system such as GNU/Linux. To "hand out" web pages, 60 per cent of Internet servers use the Apache program. Ninety per cent of the domain name system that enables browsers to find a website by calling its domain name (e.g. www.unctad.org) runs on a FOSS program called BIND. FOSS programs address similar needs and provide functionalities — such as word processing, e-mail or web browsing — similar to those of public domain, freeware, shareware or proprietary programs. A list of selected programs is given in annex II.

Comprehensive information on FOSS software can be found at Freshmeat.com and Sourceforge.com. Both UNESCO and the UNDP maintain excellent FOSS portals.[4] The following discussion of FOSS concepts and experience should be taken without prejudice to other technology production and distribution models, such as public domain, freeware or proprietary software.

2. Definitions

2.1 Formal definitions

5. There are two complementary ways of defining FOSS. First, it can be defined by the type of rights it gives to users. These rights are uniquely different from those given by proprietary programs. Second, FOSS can be defined by how it realizes these rights — that is by making its source code available to all users.

6. FOSS can also be described in terms of what it is not. FOSS is not necessarily "free of charge", even though many FOSS programs are available only for the cost of a CD or the cost of the Internet connection used for downloading them. "Free" is understood in the sense of free speech, not in the sense of "gratis" (Stallman, 2002). FOSS is also not freeware or software in the public domain. Finally, FOSS is definitely not "non-commercial"; indeed, many large companies are successfully developing, deploying or using FOSS for profit.

7. Returning to positive definitions, we can say that FOSS is software that gives its users unique freedoms and rights. According to the Free Software Foundation (1996), one of the two major entities dealing with FOSS — the other being the Open Source Initiative — free software must give its users four basic freedoms:

Freedom 0: The freedom to run a program, for any purpose;

Freedom 1: The freedom to study how a program works, and to adapt it to one's own needs;

Freedom 2: The freedom to redistribute copies of a program to help other users;

Freedom 3: The freedom to improve the program, and release those improvements to the public, so that the whole community benefits.

8. The Open Source Initiative provides a three-point criterion called the Open Source Definition:

(1) Source code must be distributed with the software or otherwise made available for no more than the cost of distribution;

(2) Anyone may redistribute the software for free, without owing royalties or licensing fees to the author;

(3) Anyone may modify the software or derive other software from it and then distribute the modified software under the same terms.

9. The common elements of both become clearer when we discover that these definitions are put into practice in very much the same ways, namely by doing two things:

- By distributing the software together with its “source code”; and
- By distributing the software under free and open licences.

2.2 Open source code

10. FOSS is software that has made its source code open to the public. Software is written using a programming language and the resulting text is called the source code. The source code determines what a program can do. But to be actually used on a computer, the source code has to be translated into object or binary code: one or several files containing a set of ones and zeros that the computer can run. Proprietary, non-free software is distributed only in binary files; the source code is a closely guarded secret and considered valuable intellectual property. FOSS users get both – the binary file to run, and the source code to inspect, modify and recompile into new object code.

11. Producers and distributors of proprietary software use the unavailability of the source code to prevent competitors, students or curious hobbyists from taking advantage of their investment in what they claim is essentially their intellectual property. The lack of source code, however, does not stop people involved in software piracy from copying the binary files and selling them on contraband CDs or posting them on peer-to-peer networks.

12. What source code secrecy prevents is other users and programmers understanding how the software works, finding and correcting bugs and security problems, improving the program by replacing original code with a better code, reusing parts of the code in their own programs, and developing new software that is capable of working well with existing programs.

2.3 Free and open licences

13. FOSS programs are distributed with specific licences that permit, or even motivate, users to inspect, modify and redistribute the source code under the same or similar conditions. Free and open licences are designed to prevent or discourage the transformation of FOSS into proprietary software. The reasoning is that if developers choose to distribute a program as free/open source, they may have an interest in keeping it, and any derivations and improvements, free and open as well. The worst reward for their work would be to have another developer hijack and redistribute the software with a proprietary licence.

14. The FSF sees proprietary software copyrights, user licences and non-disclosure agreements as a means of imprisoning knowledge and information and creating unequal access. However, the FSF is not against copyrights or copyright regulation as such, but only against proprietary licences whose objective is to restrict users. To provide an alternative to traditional and restrictive copyright statements, the FSF developed in 1983 a standard “free copyright” text, the GNU General Public License (GPL).

15. The GPL, often called “copyleft”, is formulated to prevent the closing of the source code of a computer program in order to force it into a proprietary commercial development environment. It requires users to use, simply and without exception, only the GPL should they choose to redistribute the software, either intact or modified, or as a part of another software. Once software is distributed under the GPL, it stays under the GPL practically for

ever. Any derivative software will also need to adopt the GPL. This is why the GPL has sometimes been described as a viral licence.

16. In a different approach, the Open Source Initiative does not have a prescribed licence text. Rather, it requires entities distributing open source software to satisfy the Open Source Definition (OSD) in its copyright statement. There are more than 20 approved Open Source Licenses, including the FSF GPL licence, but also licences from IT heavyweights such as IBM, Nokia and Intel.

3. The economics of FOSS

17. While giving users more rights and freedoms may be a worthwhile initiative, real-world considerations require that the basic economics of provision be examined in order to appraise the possible role for FOSS within the software and ICT services sector. The fact is that a large amount of FOSS programs are developed and used, and a substantial number of applications have become world-class standards.

3.1 Supplying a public good

18. By definition, public goods are those that simultaneously satisfy the criteria of non-rivalry and non-excludability. The consumption of a non-rival good by one consumer does not decrease its utility for another consumer. Once the final program files are produced, they can be copied an infinite number of times at almost zero cost, with no decrease in quality. Non-excludability implies that it is difficult, if not impossible, to charge people money for the use of the good: distributing the source code may reinforce this characteristic. Thus FOSS, more so than proprietary software, has the prerequisites to become a public good. In theory, programmers would cease to invest time and expertise in developing programs that they could otherwise use as free riders. The system would unravel to the point where no one would make substantial contributions and free software would stop being produced. In practice, there is little evidence of such a process and this raises several questions. Why do talented programmers choose to allocate substantial portions of their time and intellect, both of which are scarce and valuable resources, to a joint project for which they will not be directly compensated? Furthermore, why would developing countries, with limited resources and capacities, participate in and contribute to FOSS distribution and development?

19. The answer becomes more apparent when revenue streams are considered. For the software business there are two choices. One is to sell or resell proprietary user licences as well as services, such as systems integration, administration and customization. The other is to provide the software under a FOSS licence and commercialize only the service component. A number of software companies actually provide the same software under both a proprietary and a FOSS licence, in a mixed model.[5] The FOSS option can be part of a neutral and non-exclusive strategy, particularly if the company does not develop or own any software, but purely resells for a commission. A FOSS-inclusive strategy may also have merits if substantial customization or localization work is needed. The financial implications for the client of using FOSS will vary greatly from market to market and it is nearly impossible to generalize, particularly where proprietary solutions “compete” with heavy discounts[6] or through piracy.[7] The situation in some developing countries may favour FOSS, as local services and expertise, where these exist, may be less costly, while licences should have the same global prices.

20. Recognizing the possibilities of FOSS as a tool for generating revenue, rather than as a product to be sold, allows IT companies to share solutions and improvements reached while performing contracted work for clients. Underlining this approach is the notion that software is often made to order and is therefore often too specific to be commercialized and sold pre-packaged in significant volumes. Also, the mainstream proprietary software industry has indicated a large part of its income is earned from servicing and after-sales work. This is mirrored in the total cost of software ownership for clients in developed countries: the actual licence cost is but a small part of a contract with the software vendor.[8] As already noted, these cost structure generalizations may not be relevant for a developing country environment, where qualified labour can be very price-competitive or where piracy is rampant. However, FOSS expertise may also be lacking, thereby decreasing any potential benefit.

21. Moving from a business perspective to mapping the motivations of individual developers, several studies attempt explanations using conventional economic theory. An open-source programmer's code can be associated with the author and well recognized, providing a certain level of ego gratification. Commercial companies frequently review contributions to and participation in FOSS projects when assessing employability. Open-source leaders may get access to financing and attract attention from venture capital. Thus, career incentives may figure prominently in motivating programmers to contribute. These phenomena, often called "signalling incentives", can appear when inputs may be judged and rewarded in one or multiple future periods even when a contract is currently lacking (Lerner and Tirole, 2000, 2001; Holmström, 1999).

22. Raymond (1999, 2000) explains the open-source process as a gift economy whereby programmers make voluntary contributions as a reaction to abundance rather than scarcity, the abundance being that of knowledge and information as well as of network bandwidth and computing power. This implies the existence of win-neutral (i.e. benefit at no cost) or (neutral-neutral) situations with neutral or positive expectations of some direct or indirect benefit in a future period.

23. The cooking-pot model (Ghosh, 1998) suggests that FOSS comes about when users do not want to pay or charge for goods and services that thrive on the Internet. It is not a barter economy, as it does not require bilateral transactions. Millions of people on the Internet publish on matters that interest them and contribute to communities, including those involved in FOSS software. While they will not receive any cash in return, their "payment" might come in the form of complementary contributions from others or, again, the valuable outcomes of esteem and attention. Indeed, it has been suggested that what is increasingly scarce today is attention, while other factors, such as information and even financing, are becoming more abundant, if unevenly distributed (Goldhaber, 1997).

3.2 FOSS and human resources development

24. In order to develop and generally use information technology or particular FOSS programs, an economy needs trained and knowledgeable experts. Where FOSS can confer an advantage is in its capacity as a multiplier of programming knowledge and skills.

25. The most accessible example of open source code is the World Wide Web. A web page is displayed in a browser when it reads and interprets the html code for that page. This

code is usually contained in an html file received from the computer server hosting the web page. Anyone can inspect the source code of a website by clicking "View > (Page) Source" on the browser menu. This "bare all" nature of web pages enabled the fast adoption and broadest use of the World Wide Web. Amateurs and experts alike learned from one another and shared clever or effective solutions. This has led to the development of more than half a billion websites and the universal proliferation of the World Wide Web platform. While creating a web page, or html "coding" in techno-speak, can be relatively simple compared with developing software using a programming language, the analogy of access to open source code and its effect on human resources development remains.

26. Open code can be described as a global IT apprentice shop, and students and professionals have much to gain from working in an environment where information is shared and advances become part of a common knowledge base. Becoming a better programmer or having a more competitive IT service sector can be worthwhile goals from either a personal or a national e-policy standpoint. From a development perspective, locking in knowledge behind restrictive proprietary licences may not be a universally optimal strategy for human resources or technology development. Thus Governments need to consider the potential contribution of FOSS to nascent local software industries and ICT human resource capacity building. With the use of FOSS, domestic talent can learn and participate in the development or adaptation of locally relevant software, thus advancing their own IT competencies, knowledge and skills. This could help keep technology spending, experts and promising young talent, at home contributing to developing a local IT services industry.

3.3 FOSS and intellectual property

27. Intellectual property (IP) concerns are often discussed within a framework of legislative and regulatory issues. However, the economic role of IP is fundamental. IP regulation takes something abundant — information and human creativity — and makes it scarce. IP creates scarcity by restricting access, copying and distribution, thereby creating value in the microeconomic sense. This allows investment and product development within a traditional proprietary environment. As countries move towards a stricter implementation of strong IP regulation, efforts by international proprietary software producers to decrease piracy improve the fundamental conditions for increased adoption of open-source software as well.

28. FOSS, just like proprietary software, comes with user licences and relies on IP regulation for protection and legal remedy. Without IP regulation, FOSS enters the public domain and loses its value, thus rendering development and commercial exploitation difficult, if not impossible. While FOSS generally allows free access, copying and distribution, its licences restrict or discourage bringing these activities under a proprietary licence.

29. It is a gross misunderstanding to view FOSS as an alternative to respecting IP. FOSS GPL or OSD licences oblige users to, without exception, respect the terms and conditions of use as chosen by the software's author(s). The current debate often pits proprietary licensing against the GPL. Proprietary software producers argue that promoting the GPL means locking out software from commercial development and distribution under a proprietary licence. However, proprietary licensing allows only the owner to commercialize the intellectual property at stake. Thus, the formal outcome is not that different from that of the

GPL (Lessig, 2002). In terms of ICT strategy and its relation to innovation and development, there have been indications that the proprietary model may encourage excessive copyrighting and patent hoarding, with the final outcome being reduced investment in research and development (R&D) activities and a decline in innovation as funds for R&D are redirected towards patent acquisition aimed at generating rent income through royalty payments (Bessen, 2002; Bessen and Hunt 2003).

30. Technology consumers generate demand primarily through a process of learning by doing whereby they gradually come to understand what the technologies can do for them, and then examine new possibilities. An environment where software is normally used under restrictive licensing may not be the most conducive for exploring policy and practice for ICT development and bridging the digital divide. The empowerment that comes with FOSS is not a simple price advantage, but may rather be an economic prerequisite for evolving demand. The policy issue for governments is to consider what regime for ownership and distribution of software best serves their development interests. In an FOSS environment, the degree to which a software tool can be used and improved is limited only by the knowledge, learning and innovative energy of its users, and not by restrictive licences, prices or the power of other countries and corporations.

4. Government policy and FOSS

31. It is often said that, in reality, consumers choose software on the basis of cost, security, functionality and device compatibility.[9] However, Governments are publicly funded and designated to perform in the public interest. Use and procurement objectives may therefore be different or broader. FOSS has often been suggested as a potentially good match for government use. However, such considerations can easily deceive: procurement and use are not effected “in principle”, but in order to satisfy a certain need. Thus public interest requires the efficient use of public funds for well-specified needs.

32. Judgements about needs and efficiency can be vastly different from a public perspective as compared with an individual one. Governments may choose to achieve overall usage efficiencies beyond those apparent in, for example, a particular administrative task or department. They may have an interest in using technology that has important positive externalities, and these need to be included in the efficiency calculation and the criteria of merit. Examples of externalities would be software localization, effects on overall human capacities and skills, mobilizing local IT services companies or producing software available for redeployment to society at large under a permissive licence. All these are formally more achievable with FOSS because of the available source code and its anti-restrictive licences. Given that Governments are important IT consumers in many developing countries, such positive externalities may be an important factor in countries’ efforts to adopt digital technologies.

33. An often discussed and important consideration is managing and storing public data with open code and in open file formats. Government may choose not to lock public data into proprietary data formats and may prefer not to process it with secret-code software. The combination of proprietary formats and vendor failure is seen as particularly unsuitable where data permanence is needed. Pursuing ambitions for greater transparency in governance, and using proprietary software and file formats to collect and manage tax data, vote counts, civil information or health records, may become an unpopular proposition. FOSS programs and

their corresponding file formats bare all and allow the benefit of unrestricted and neutral inspection. A related issue is that citizens should not be forced to purchase or use a particular technology in order to gain access to government data or to their own data as submitted to their Governments.

34. Finally, respect for intellectual property rights has been on the international agenda, and organizations and UN agencies such as the WTO and WIPO have been promoting compliance among Governments in developing countries. There is no denying that given the current trends towards stronger IP regulation and enforcement, developing countries need to have corresponding IP regimes and functional legal systems in place in order to accommodate the conduct of trade and investment. However, developing countries are, for the time being, net IP importers and will be increasingly so with the strengthening global IP regime if they do not develop their own high-value-added technology industry and exports. Given their limited resources, developing country Governments may achieve IP compliance with fewer resources and difficulties by promoting FOSS use and open content, then by popularizing proprietary technologies and then "investing" in law enforcement and litigation against pirates.

35. Policy implementation can have different levels of formality, from awareness to guidelines for procurement or investment, all the way to legislation prescribing FOSS use whenever possible in public entities. One frequent question often asked in FOSS policy discussions is: should Governments positively legislate the use of FOSS? Unfortunately, there is no clear answer. Suffice it to say that if the economic and development logic is valid, strong legislation may add little. Where legislation helps is in restricting activities that have no economic or social upside, such as not using safety belts in vehicles. While it is not the norm, certain administrations and policy makers have proposed or enacted FOSS legislation in the belief that the alternatives are generally a net loss for society.

5. FOSS and commercial and business applications

36. FOSS has often been misrepresented as non-commercial software created for and by hackers, and therefore it may not have many relevant applications for commercial and business use. In fact, many established Internet business and websites, such as Google.com, Yahoo.com and Amazon.com, use FOSS operating systems or web server software.

37. The Open Source Initiative was established in order to promote the use of free software in commercial environments. It chose to employ the term "open source software" instead of "free software" in order to avoid the ambiguities of using the term "free" in a commercial or business context. It argues that the open source development process produces better and more reliable software with obvious advantages in terms of open standards, security, support, bug fixing and future development – all important business considerations.

38. Increased security is directly related to open code as this exposes it to public scrutiny. Problems found are fixed instead of being kept secret until discovered or abused by malevolent hackers. Of all these benefits, the most fundamental is increased reliability. A June 24 reading of the Netcraft survey of the top 50 servers with the longest up time between rebooting showed all of them to be running FOSS operating systems and web servers. Reasons for reliability may vary. Most discussions focus on the quality of a well-managed peer-review process and transparency in terms of "given enough eyeballs, all bugs are

shallow."[10] David Filo, co-founder of Yahoo!, explained his motivations for choosing FOSS this way: "Although the price was certainly attractive, it was the stability, performance, and access to the source code [of the FreeBSD operating system] that sold us."[11]

39. The Open Source Initiative suggests that there may also be advantages from the open source process for companies that write bespoke software for sale. Using the developer community resources, open source development can achieve short time to market with a working "beta" version. This is followed by a customization phase where a number of iterations of test and code review are performed in close consultation with the client in order to reach the desired combination of features and performance. FOSS licences and the absence of non-disclosure agreements can facilitate this client–developer interaction. Finally, as mentioned before, the value proposition may be in the service and the expertise associated with the software.

40. This discussion will remain impartial and refrain from showcasing particular FOSS applications for various business uses, such as office productivity or database programs, beyond those described in annex II. Businesses may find it useful to research FOSS options using online resources and explore possibilities of cooperation with software service companies providing open-source-based solutions. Contracting software development without receiving the source code files adds a substantial risk for the procurer. If the developers disband or their company closes, the application may become difficult to service, upgrade or continue developing. Owning the software code gives the option to release it under a FOSS licence, in particular if it is too specialized to have volume sales potential "as is".

6. The effect of FOSS on other sectors

41. Three notable areas where open- and free-source approaches are making inroads are publishing, biology and creative endeavours.

42. Open content is the content production process together with the content itself, when it is distributed according to an open-content licence agreement. The basis for open-content licensing is that content is freely available for modification, use and redistribution, with certain restrictions aimed at supporting its freedom from the threat of proprietary closing (Keats, 2003). The best-known open content project is probably the Wikipedia encyclopaedia. The English version has more than three hundred thousand entries and its content is editable online, thus providing a massive peer review process. A number of open-content directories and projects have sprung up,[12] inspired in part by dissatisfaction among teachers and lecturers with the rising cost and decreasing quality of new editions of textbooks.[13] In the development context, given the cost of content as well as the under funding of schools and the lack of expertise in many countries, collaborative development of content in an open environment and process could improve access to high-quality, locally relevant content. Open content has great potential to contribute to a "knowledge commons" that can have a positive effect on economic development. Governments and the UN system may consider contributing to a shared global body of knowledge by changing the copyright of many of their publications, documents, training materials and other content, which are almost always produced with government or public funds, to open content licences.

43. FOSS software allowed the public Human Genome Project at the Sanger Institute to assemble the genome in parallel with Celera's commercial effort, thereby ensuring that the human genome data would remain in the public domain.[14] This positive outcome demonstrated the need to think about more than just open source code; in the scientific community there is awareness of the importance of open data and procedures, as replicability is the only guarantor of scientific validity.[15] Without a public open-source competitor, the human genome may have wound up in the proprietary domain, available to those capable of paying for a subscription to what many consider the common heritage of humanity.

44. Other organizations have been imitating the FOSS model. Bioinformatics.org aims to "promote freedom and openness in the field of bioinformatics [and] hopes to lower the barrier to entering and participating in the field of bioinformatics, as access to cutting-edge resources can be prohibitively expensive for those working individually, in small groups, at poorly funded institutions or in developing nations".[16] In another example, the Alliance for Cellular Signaling will develop software for a virtual cell that will allow scientists to perform simulated experiments completely on their computers. Replicating the FOSS process, several laboratories will act as central coordinators, and hundreds of researchers are expected to contribute over the Internet.[17]

45. Creative endeavours, much like software, depend on the processes of assimilation and derivations based on current work or work done in the past. In doing so, they encounter restrictive IP and the resulting problems. The Creative Commons project was set up to provide a less restrictive environment within the framework of standard IP legislation. Like free software, Creative Commons uses private rights to create public goods, but not necessarily for the public domain. Its objective is to provide reasonable and flexible copyright models as an alternative to the increasingly restrictive default prescriptions. Creative Commons has developed a Web application that helps people formulate the appropriate licence for their work. The licences are specifically designed for creative content: websites, scholarship, music, film, photography, literature, courseware, and so forth. The objective is not only to increase online content, but also to make access to that content cheaper and easier. This will be done using metadata that associates creative works with the chosen licence profile and makes this known to search engines and browsers. Content with clear, yet complex, licensing conditions may decrease the need for legal intermediation, thus reducing barriers to creativity and the sharing of cultural and artistic values.

7. Conclusions

46. FOSS presents a significant development opportunity because of the critical role that users can play in determining the need for software products and influencing the overall trajectory of technology evolution. Software innovations can and should come increasingly from developing countries. Developing countries are not implicitly dependent on commoditized, proprietary innovation from the developed world. In a FOSS environment, their own users, be they individuals, Governments or businesses, could push technology development towards applications that specifically address local needs and demands. However, for indigenous demand to be expressed, users need to understand the possibilities they have and the ways in which a digital infrastructure could contribute to their lives.

Given the importance of the FOSS issue and the timeliness of the debate, Governments should consider having policy on FOSS expressed as part of their overall e-strategy. While

there are many good reasons to favour FOSS, these should be evaluated on the basis of the realities of one's own digital readiness and an assessment of other factors such as connectivity, human resources and potential for the development of a local software services sector. From a development perspective, FOSS has a number of positive characteristics. The task for policy makers is to determine whether and how these can be exploited.

References and bibliography

Berlecon Research and the International Institute of Infonomics (III), University of Maastricht (2002). *Free/Libre and Open Source Software: Survey and Study.* http://www.infonomics.nl/FLOSS

Bessen J (2002). What good is free software? In: Hahn R, ed. (2002). *Government Policy toward Open Source Software*. Washington, DC, AEI-Brookings Joint Center for Regulatory Studies.

Bessen J and Hunt R (2003). An empirical look at software patents. Research on Innovation. http://www.researchoninnovation.org

Evans SD (2002). Politics and programming: Government preferences for promoting open source software. In: Hahn R, ed. (2002). *Government Policy toward Open Source Software*. Washington, DC, AEI-Brookings Joint Center for Regulatory Studies.

Free Software Foundation (FSF) (1996). The free software definition. http://www.fsf.org/philosophy/free-sw.html

Ghosh RA (1998). Cooking pot markets: An economic model for the trade in free goods and services on the Internet. *First Monday* 3 (3).

Goldhaber MH (1997). The attention economy and the Net. *First Monday* 2 (4).

Holmström B (1999). Managerial incentive problems: A dynamic perspective. Working Paper 6875. Cambridge, MA, National Bureau of Economic Research.

Keats D (2003). Collaborative development of open content: A process model to unlock the potential for African universities. *First Monday* 8 (2).

Lerner J and Tirole J (2000). The simple economics of open source. Working Paper 7600. Cambridge, MA, National Bureau of Economic Research.

Lerner J and Tirole J (2001). The open source movement: Key research questions. *European Economic Review* 45.

Lessig L (2002). Open source baselines: Compared to what? In: Hahn R, ed. (2002). *Government Policy toward Open Source Software*. Washington, DC, AEI-Brookings Joint Center for Regulatory Studies.

Open Sources: Voices from the Open Source Revolution (1999). DiBona C, Ockman S and Stone M, eds. O'Reilly & Associates, Sebastopol, CA.

Pappas Johnson J (2001). Economics of open source software. F/OSS, Massachusetts Institute of Technology.

Raymond ES (1999). The magic cauldron. http://www.catb.org/~esr/writings/magic-cauldron/

Raymond ES (2000). The cathedral and the bazaar. http://www.catb.org/~esr/writings/cathedral-bazaar/

Stallman R (1999). The GNU operating system and the free software movement. In: *Open Sources: Voices from the Open Source Revolution*.

Stallman R (2002). Free as in freedom. Ongoing. http://www.oreilly.com/openbook/freedom/

Annex I

Selected FOSS initiatives in developing countries

This annex presents a selective and brief overview of developments in FOSS policy and practice in a number of developing countries. These are neither comprehensive nor conclusive. Developments in developed countries have been left out, as these are easier to find and are better known.

Argentina
The bill entitled "Policy for Free Software Use for the Federal State" calling for mandatory government use of FOSS, was presented to Argentina's House of Congress in April 2001. However, the economic crisis forced the Government out before a vote could be taken. A similar bill was resubmitted in March 2002 and is under review. The current bill proposes FOSS as a component of the national campaign against software piracy.[18]

Brazil
Rio Grande do Sul was the first administration to pass a law making the use of FOSS mandatory in both government agencies and non-government-managed utilities. Four cities in Brazil have passed legislation requiring preference for "software libre" where an open-source option is available. The national health care system plans to release 10 million lines of source code. The first annual Free Software International Forum was held in Brazil in May 2000. In the province of Pernambuco, the world's first law regarding the use of open-source software was passed in March 2000.[19]

China
The Government-supported China Academy of Science, together with the Government-owned Shanghai New Margin Venture Capital, established Red Flag Linux, a Chinese-language Linux distribution. The Beijing Software Industry Productivity Center was established by the Beijing municipal government and has launched a project called "Yangfan" to improve the performance of local distributions of GNU/Linux. The strong presence of international FOSS developers, including Turbo Linux, Red Hat and IBM, is noticeable.[20]

India
A growing attraction to Linux in India has persuaded Microsoft to share source code with a particular government body. The Simputer was developed by a group of scientists from the Indian Institute of Science and Encore Software. Government agencies promote the use of localized solutions such as local-language computing. The Centre for Development of Advanced Computing and the Department of Information Technology are supporting the development of a Hindi GNU/Linux distribution called Indix. The Department of Information Technology has expressed the intention to introduce Linux as the de facto standard in academic institutions; research establishments will develop distributable toolboxes; and central and state governments will be asked to use Linux-based offerings. The West Bengal Electronics Industry Development Corp Ltd., the state's nodal IT body, has formed a Linux cell to support various government IT projects inside and outside the state. Talks with major FOSS industry players on joint projects are in progress.[21]

Malaysia
The Government committed itself in November 2001 to using FOSS in key agencies such as the Treasury, and in areas such as e-procurement. The Malaysian National Computer Confederation operates an FOSS special interest group. The Prime Minister launched the Komnas (Komputer Nasional) Twenty20 Personal Computer, built on FOSS by the private sector. The Malaysian Institute of Microelectronic Systems, the ICT adviser to the Government, is pushing the shift towards FOSS, including an attempt to build a low-cost PC based on GNU/Linux.[22]

Pakistan
The Government Technology Resources Mobilization Unit has created a "Linux Force" task force that is expected to help Pakistan move toward FOSS. This would include funding for R&D programmes for client software, training and local-language application development.[23]

Peru
Congressman Edgar Villanueva introduced Bill 1609, entitled "The Use of Free Software in Public Administration", to mandate the use of FOSS in all government systems. His open discussions with Microsoft Peru have earned him and Peru the reputation of being the developing world's FOSS radical voice.[24]

Philippines
Bayanihan Linux, developed under the Open Source Project of the Advanced Science and Technology Institute of the Philippines, has had its second release and is bundled with the latest office suite, image and text editors, Internet and networking tools, and multimedia applications. Bayanihan is a single-CD installation tailored to local demand.[25]

Republic of Korea
The local company HancomLinux signed a deal in January 2003 with the country's Central Procurement Office to supply the Government with 120,000 copies of its Linux desktop office productivity software, known as HancomOffice. The open-source software, which is compatible with Microsoft's Office applications, including Word and Excel, is expected to save the Government money in the long run and stimulate business for local companies competing against Microsoft in the software industry.[26]

South Africa
A government council convened to consider the use of FOSS published an official recommendation promoting the use of open-source applications when proprietary alternatives do not offer a compelling advantage, and highlighted the necessary strategic steps. In January 2003, the Government declared that it would use FOSS and set up a council for scientific and industrial research to help develop programming skills. South Africa has taken the lead in regional collaboration on open-source software, including the Free and Open Source Software Foundation for Africa.[27]

Thailand
The Government-supported technology development group NECTEC has developed a GNU/Linux distribution for schools and government desktops and servers — the Linux-SIS (School Internet Server) for servers and the Linux TLE (Thai Linux Extension) for government desktops. The project aims to narrow the gap between the use of pirated and legal software, and to promote local business development.[28]

Viet Nam
Government delegates to a software seminar in Hanoi concluded that Viet Nam could save hundreds of millions of dollars annually and better guarantee information security by switching to FOSS. Vietnamese IT companies are working on FOSS projects by subcontracting with foreign companies and FOSS was included in the National Program on Information Technology.[29]

Annex II

Selected examples of FOSS

FOSS is often used in mission-critical environments. Many industry standard applications are in fact open-source programs. Selected notable open-source programs are discussed below. More complete listings of FOSS software can be found at the UNESCO and UNDP websites.[30] There are many websites that host FOSS development or catalogue FOSS programs. Among the more popular are sourceFORGE.net and freshmeat.net.

The open-source web server software **Apache**, which sends web pages to the computer of someone accessing a website, has dominated its market segment since 1996 and now has at least twice the market share of its nearest competitor.
http://www.apache.org

GNU/Linux has long been popular as an operating system running computers that perform as web servers. Recent surveys show that GNU/Linux runs 29.6 per cent of web servers. In the last few years it has increasingly penetrated both the high and the low ends of the enterprise market for server operating systems. GNU/Linux runs on Intel/AMD type PCs, while versions for other hardware have been developed as well. To install GNU/Linux, one must have a "distribution". One can buy a CD, download or make a distribution. Linux Online is but just one website with comprehensive information, FAQs and links. However, there are many professional and amateur online resources for GNU/Linux that may be explored and used.
http://www.gnu.org/

The **BSD/OS/FreeBSD/NetBSD/OpenBSD** family of operating systems are UNIX-based, free/open-source operating systems similar to GNU/Linux. Developed at the University of California-Berkeley in the 1970s, BSD is considered one of the most secure and stable operating systems and runs a large percentage of Internet servers. The core of Apple's Macintosh operating system, Darwin, is based on FreeBSD and has remained in the open-source realm.
http://www.bsd.org/

GNU was the predecessor of GNU/Linux. It is a free version of UNIX tools created by Richard Stallman in 1984. GNU stands for "GNU is not UNIX".
http://www.fsf.org/

Sendmail is a free/open-source programme used for routing approximately 40 per cent of the email that travels over the Internet.
http://www.sendmail.org/

Perl (Practical Extraction and Report Language) is a scripting language freely available for UNIX, MS/DOS, Macintosh, OS/2 and GNU/Linux, among others. It has powerful text-manipulation functions and is used extensively for programming Web electronic forms, and generally for generating interfaces between systems, databases and users exchanging data on the Internet.
http://www.perl.com/ ; http://www.perl.org/ ; http://www.perlfoundation.org/

BIND (Berkeley Internet Name Domain) is a free/open-source programme that allows Internet domain names to be entered as text-based names instead of as IP addresses, or series of numbers, thus making it easier for users to reach sites on the Internet.
http://www.isc.org/products/BIND/

The Beowulf Project is a method of connecting computers to form a high-performance computer (Beowulf cluster) that approaches "super-computer" performance. Since a Beowulf cluster can be developed from common, off-the-shelf computers utilizing FOSS, a Beowulf cluster "super-computer" can be built at a fraction of the cost of other systems with similar computing capacity.
http://www.beowulf.org/

OpenOffice.org is a software suite that provides basic office and administrative automation. An offshoot of Sun Microsystems' StarOffice, OpenOffice runs on all major operating systems, including MS Windows, as its cross-platform functionality is based on open XML standard file formats.
http://www.openoffice.org/

GNOME and **KDE** are desktop graphic user-interfaces that run on top of GNU/Linux and UNIX, providing user-friendly computing to the non-programmer open-source community.
http://www.gnome.org/ ; http://www.kde.org/

MySOL and **Postgres** are database servers.
http://www.mysql.com/ ; http://www.postgresql.org/

The Gimp is a graphics programme widely distributed with GNU/Linux. A version for the Windows operating system also exists. It is sometimes called "free photoshop".
http://www.gimp.org/

Notes

[1] This background paper is largely based on chapter 4 of UNCTAD's *E-Commerce and Development Report 2003*, UNCTAD/SITE/ECB/2003/01, entitled "Free and open-source software: Implications for ICT policy and development".

[2] See http://r0.unctad.org/ecommerce/ecommerce_en/freeopen_en.htm .

[3] The following FOSS events were held during the WSIS conference in Geneva:

1. ICT4D Event, 10 December 2003: 10.19 Creating Free and Open Source Software (FOSS) Infrastructures;
2. ICT4D Event, 11 December 2003: 8.4 Technology Choices for Decision-Makers (Open Source Software (OSS) solutions and technologies);
3. ICT4D Event, 12 December 2003: ICT4D Forum - 1.2 Innovating for Equitable Access: Open Source Software - Pros and Cons From a Development Perspective;
4. WSIS Event, 9 December 2003: Software libre para una soc. del conoc. igualitaria y multicultural;
5. WSIS Event, 10 December 2003: "Free Software, Free Society" /"Logiciel Libre, Société Libre";
6. WSIS Event, 11 December 2003: Faire le choix des logiciels libres : une contrainte ou une solution?;
7. WSIS Event, 11 December 2003: Freedom in E-culture-Experiences & models - Conference 1: Richard M. Stallman, founder of Free Software Foundation and of GNU Project: "Free software, free society GNU/Linux projects".

[4] See the UNDP portal at http://www.iosn.net/ and the UNESCO portal at http://www.unesco.org/webworld/portal_freesoftware/ .

[5] MySQL, TrollTech and Sleepycat are but several examples. See http://www.mysql.com/news-and-events/press-release/release_2004_10.html .

[6] See http://www.metamorphosis.org.mk/eng_vesti_detal.asp?id=37 , http://www.infoworld.com/article/04/07/29/HNcheapwindows_1.html or http://asia.cnet.com/newstech/systems/0,39001153,39136847,00.htm .

[7] Microsoft's Chief Executive Officer, Bill Gates, is quoted in *Fortune* magazine, 20 July 1998, explaining tolerance of piracy in China as follows: "As long as they're going to steal it we want them to steal ours. They'll get sort of addicted, and then we'll somehow figure out how to collect sometime in the next decade."

[8] The UNCTAD E-Commerce and Development Report 2003 explains that even Microsoft has reportedly conceded, in line with the findings of a survey by the Gartner Group, that the cost of software licences amounts to only 8 per cent of the total cost of ownership, and that the other 92 per cent reflects the costs of installation, maintenance, management and repairs after failures. This explanation comes from the letter that Microsoft addressed to Peruvian Congressman Edgar Villanueva, arguing against his ambition to legally designate FOSS a preferred option for government procurement.

[9] See Microsoft's discussion of open source at http://www.microsoft.com/resources/sharedsource/Government/opensource.mspx

[10] Raymond (2000). The cathedral and the bazaar, http://ww.catb.org .

[11] See FreeBSD Newsletter at http://www.bsdnet.dk/files/issue1.pdf .

[12] See http://www.wikipedia.org/wiki/Open_content for a list of open content projects and links.

[13] See http://www.lightandmatter.com/article/article.html .

[14] See http://www.sanger.ac.uk/HGP/ .

[15] See http://www.oreillynet.com/pub/a/network/2002/04/05/kent.html and http://www.wired.com/news/medtech/0,1286,46154,00.html for more details.

[16] See http://bioinformatics.org/ .

[17] See http://www.newamerica.net/index.cfm?pg=article&pubID=901 and http://www.cellularsignaling.org/ .

[18] See www.lugcos.org.ar/serv/mirrors/proposicion/proyecto/leyes/#ref.#1.

[19] See www.softwarelivre.org/index.php?menu=projeto and www.pernambuco.com/tecnologia/arquivo/softlivre1.html.

[20] See www.redflag-linux.com/eindex.html and www.bsw.gov.cn.

[21] See www.zdnetindia.com/techzone/enterprise/stories/74137.html ; www.simputer.org/simputer/ ; http://rohini.ncst.ernet.in/indix/ ;

http://economictimes.indiatimes.com/cms.dll/xml/uncomp/articleshow?artid=24598339 ; www.zdnetindia.com/news/national/stories/71697.html ; and http://ebb.antville.org/stories/362705/ .

[22] See http://asia.cnet.com/newstech/systems/0,39001153,39071821,00.htm ; http://star-techcentral.com/tech/story.asp?file=/2002/9/9/technology/09oss&sec=technology ; www.mncc.com.my/oscc/oscc-main.html ; and http://opensource.mimos.my/ .

[23] See www.tremu.gov.pk/task/Linux.htm .

[24] See http://odfi.org/archives/000004.html#4 .

[25] See http://bayanihan.asti.dost.gov.ph/ .

[26] See http://en.hancom.com/index.html .

[27] See www.oss.gov.za/ .

[28] See www.nectec.or.th/linux-sis/ .

[29] See www.idg.com.sg/idgwww.nsf/unidlookup/21744381DA98B64148256CA80007772E?OpenDocument.

[30] See note 3.