E/CN.16/2001/Misc. 5
4 April 2001

ENGLISH ONLY

COMMISSION ON SCIENCE AND TECHNOLOGY
FOR DEVELOPMENT
Fifth session
Geneva, 28 May to 1 June 2001

CHANGING DYNAMICS OF GLOBAL COMPUTER SOFTWARE AND SERVICES INDUSTRY: IMPLICATIONS FOR DEVELOPING COUNTRIES

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EXECUTIVE SUMMARY

In its resolution 1999/61, under paragraph 11(b), the Economic and Social Council requested the Secretariat of the Commission on Science and Technology for Development to examine case studies of approaches to address issues related to technology, intellectual property rights and biosafety issues in practical, understandable and concrete way. This report is being submitted pursuant to that request.

With the growing importance of knowledge-based industries such as computer software, the importance of intellectual property rights (IPRs) is at the same time being enhanced. The actual role and impact of IPRs, however, is being debated especially in relation to the process of developing domestic technological skills and capabilities in a globalized economy. On the one side of the debate, there are those who believe that the impact of IPRs is determining the sectoral economic performance while on the other side of the debate, others perceive the impact of IPRs as a hindrance to indigenous technological development. This study reviews the debate in the context of computer software development in developing countries, with a view to expanding the economic opportunities of developing countries in this sector. The overall aim of this paper is to inform developing countries of new trends in this sector and their relevance to policy making and future international negotiations on related issues. The paper demonstrates the growing importance of computer software by reviewing recent global trends in copyright-based industries, especially the associated growing demand for all information-based industries since the mid-1980s and the potential for developing countries to enter global markets in this area.

ABBREVIATIONS AND ACRONYMS

AISI	African Information Society Initiative
AOL	America Online
BSA	Business Software Alliance
DVD	Digital Video Disk
EC	European Commission
ERP	Enterprise Resource Planning
EU	European Union
FM	Facilities Management
GATT	General Agreements on Tariffs and Trade
GDP	Gross Domestic Product
HTTP	Hyper Text Transport Protocol
ICC	International Chamber of Commerce
ICT	Information and Communication Technology
IDC	International Data Corporation
IDSA	Interactive Digital Software Alliance
IIPA	International Intellectual Property Alliance
ILO	International Labour Organization
IPC	Intellectual Property Committee
IPR	Intellectual Property Right
ISP	Internet Service Provider
IT	Information Technology
NAFTA	North American Free Trade Agreement
NASSCOM	National Association of Software and Service Companies (India)
NC	Network Computer
NGO	Non-Governmental Organization
NIC	Newly Industrialized Country
OECD	Organization for Economic Cooperation and Development
OS	Operating System
PC	Personal Computer
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization
WT	Windows Terminal
WTO	World Trade Organization
WWW	World Wide Web

1. INTRODUCTION

Countries around the globe have become more information and knowledge-intensive, giving rise to the phenomenon of the knowledge-based economy. The increasing importance of knowledge to economies is a truly international trend which affects all levels of development. In major Organization for Economic Cooperation and Development (OECD) countries an increasing proportion of Gross Domestic Product (GDP) is now attributed to knowledge-based industries, telecommunications, computer and information services, finance, insurance, royalties and other business services (OECD, 1998a). Knowledge-based industries are not only growing faster but also account for an increasing proportion of trade in most developed economies (Department of Trade and Industry 1998). Policy makers have therefore come to recognize the growing importance of knowledge and intellectual assets as principal sources of value, productivity and growth where global interaction is increasingly in the form of knowledge exchange. Although countries recognize the growing importance of knowledge-based activity and exchange in their economic and social well-being, there are nevertheless, major gaps between developed and developing countries in abilities to generate, harness and trade knowledge-based goods and assets.

The computer software and services industry is a key exemplar of knowledge production, as the value of what a software company produces is almost entirely in the knowledge embodied in its products and services. It is a fast growing industry producing high value services for its customers. Although it is dominated by firms based in major industrialized countries of the world, it continues to offer great prospects for economic growth and industrial development within developing economies. Indeed, the software industry has become a leading source of employment creation and economic growth in the world (Schware, 1995).

In addition, software has become a key facilitating technology making it a major strategic technology for growth and development. Software and computer services centrally underpin the actual creation, but also the efficient utilization of core aspects of modern manufacturing and the physical products that are produced (Alic, 1994). Few areas of production, engineering or education do not include software as an important and increasingly complex component (Schware, 1990). Moreover, new small firms with relatively few tangible assets can still prosper and grow rapidly and with the rise of the Internet, where these firms are physically based is becoming less important. However, because of the unique way that knowledge is generated and traded in the software industry (and other knowledge-intensive industries), protection of intellectual property forms a fundamental element as to how the sector has grown and developed. The objective of this report is to provide an exploration of the issues surrounding the development of the computer software and services industry in developing countries and how intellectual property rights influence establishment and growth within these countries.

It should be noted that the report remains exploratory in nature, based as it is on secondary material and analysis. The availability of reliable and comprehensive data on computer software and particularly services, remains at best partial and at worst non-existent. This hinders making, at this stage, specific and detailed analysis of the key features of the growth and development of computer software and services industry in an international

context. Nevertheless, the report raises key issues surrounding computer software and services and the role of intellectual property rights in its development. The following section will outline in more detail the nature and contents of the report.

2. CHANGING DYNAMICS OF THE COMPUTER SOFTWARE AND SERVICES INDUSTRY

The development of the computer software and services industry, (as with the establishment of the computer hardware industry) was centred on user organizations that needed software to run simple programmes on computers. The earliest operating systems (OS) were written by users to work on computers they had been purchased from manufacturers or had been developed in-house. However by the 1960s, computer hardware manufacturers realized that to optimize the utilization of their computers requirements, they also provided the (increasingly complex) software. Developments in software allowed faster utilization of processing capabilities and improvements in peripheral devices, such as printers and disk drives (Steinmueller, 1995). Such benefits in performance helped to improve hardware sales. At this stage almost all software was provided free by manufacturers as a mechanism to market their machines.

Not surprisingly hardware manufacturers, above all International Business Machines (IBM), were central players in the software industry throughout this period. This all changed, though, with the 1969 court ruling requiring IBM, under anti-trust pressure from the United States Department of Justice, to unbundle its hardware and software services. This ruling prevented IBM from marketing computer hardware with free software “bundled” as a package selling price. Despite this, users remained important in the development of the computer software and services industry often selling in-house products to clients. If these software and services units became successful, they were spun-off by the parent company to become independent software houses. Examples of this externalization phenomenon remain common in both Europe (Howells, 1987; 1989a) and Japan (Baba, et al., 1995).

With the rise of the mini and micro computers in the late 1970s, precipitated by the introduction of the personal computer in the early 1980s and the numbers of potential computer users multiplied. Most of these new users could not afford develop their own software (applications software) to allow them to tailor the OS software to their own requirements. This gave rise to low cost “packaged”, integrated software which began to dominate the share of overall computer software and services market and by the mid 1980s, the market for computer software and services was “coming of age” with a mix of systems, applications and integrated software providers with often rapid change in the market share and position of leading providers (OECD, 1985; 1989). The growth of the low cost personal computer (PC) was accompanied with the rapid rise of standard packaged software. Such packaged software was centred around basic word processing packages, such as WordStar produced by MicroPRo International and spreadsheet applications, such as Lotus 1-2-3. Prices of personal computers continued to decline and by the end of the 1980s there were virtually thousands of different packages users could select. By the early 1990s, Microsoft building on its earlier success of its DOS system, began to make its mark in the software industry with its first offerings of the Window system.

Away from the personal computer-based packaged software, there was also an increased demand for large system integrators in the early 1990s, which sought to offer more complete solutions to large corporations running large mainframes with an ever expanding mix of mini and micro computers. Companies, such as Electronic Data Services (EDS) and Computer Sciences Corporation in the United States and Cap Gemini Sogeti and Sema in Europe, began offering these large corporations complete outsourcing packages, where the client could outsource all its computing and software activities to these new systems houses. The computer services company would generally hire all the information technology service staff from the client company and in return be offered a long term contract running for perhaps ten years or more. At one level, the computer software and service industry was offering more standard and user-friendly software packages that could be run on personal computers and at another level sought to overcome the increased complexity of business software by completely taking over the function and offering a "black box" service to the customer.

2.1 Key Trends and Issues

The computer software and services industry continues to grow rapidly. In 1996, the global software market was $95 billion. According to International Data Corporation (IDC), the worldwide software by 2000 was estimated to be worth some $180 billion. This growth in itself has had a number of important implications both for the industry and more generally in terms of economic development. The first has been a change within the nature of the industry itself. Increasingly, due to the growth and profitability of the industry, the software and services side of the whole computer sector is playing an ever more pivotal role in the wider computer industry. Although computer hardware manufacturers have always played an important role within the industry itself, computer services and system activities are taking on an ever more prominent role in terms of turnover share and profit levels. Companies like IBM are becoming increasingly system integrators and providers of solutions—in short, they have become more service oriented. In some cases, such as ICL from the United Kingdom (part of Fujitsu), they have completely shifted away from manufacturing to become a system integrator and software developer. Even in more "traditional" electrical and electronic engineering companies, software has become a more central activity. Thus, it has been estimated that Siemens, for example, spends over 60 per cent of its R&D budget on software development. Lastly, the profitability and growth of computer software and services companies is reflected in the value that financial markets place on these companies. Thus Microsoft, although a much smaller company in terms of manpower compared with IBM, is worth approximately ten times more than its counterpart.

This growth, however, has also created problems for the industry. The industry remains chronically short of skilled manpower. In Europe alone, it is estimated that the industry is short of some 500,000 skilled workers. Japan and the United States are also severely short of computer service personnel. This shortage continues to provide good opportunities for countries to take-up this slack and provide skilled people to fill the gap. The international spread of the industry has not only resulted in capturing new markets, but also as an opportunity to draw upon untapped pools of skilled, numerate workers.

In part, this shortage is a reflection of what has become known as the "software crisis" within the industry. In brief, this crisis can be characterized as the "late delivery of expensive,

unsatisfactory and unmaintainable software systems" (Jones, 1990). In turn, the inability to complete current work on time and within budget has meant that maintenance and new developmental work has been delayed. If the problems associated with the crisis, such as poor productivity and software reusability (Glass, 1994) were resolved, labour requirements would be lower and the labour shortage would be reduced. Initiatives such as Japanese "software factories" (Cusumano, 1989) and the more widespread introduction of reusable software code have always been hailed as offering the ultimate solution to the problems. Nevertheless, the crisis drags on. However the nature of the problems within the crisis have changed. A key constraining problem in the past was lack of computational power, where programmers were confronted with scarce programming power and memory. Today the constraining factor is complexity, as the software (and hardware) must be effectively integrated right from the outset. Paradoxically, much of the rapid growth in the industry in developed economies has been characterized by shortage and constraint. Developments within the sector have been shaped by attempts to get away from, or to resolve, these constraints and shortages, either by adopting new methods or by moving into new geographical areas.

2.2 Key Players and International Expansion

Although there are many other important players within the industry holding key positions within certain computer software and services markets (such as SAP from Germany, within Enterprise Resource Planning (ERP) software, or the United States-based company, EDS in terms of providing outsourced computer services), Microsoft has dominated the industry since the beginning of the 1990s. However, in a sense, its power and influence extends beyond simple market dominance or market capitalization, its power also stems from its influence on the whole thinking of the industry and from how Microsoft's competitors and collaborators respond to its changes in strategy. Nevertheless, does size matter. In terms of software sales, (Table 2.1) Microsoft has over twice the market-size of its nearest competitor, Oracle. Moreover, Microsoft's turnover grew by 29 per cent between 1998-99 (although for some smaller software companies growth rates were higher). What is also evident is the dominant position of United States companies. Only two companies in the top twenty listing are non-United States high technology companies, SAP from Germany and Misys from the United Kingdom. Even in the top 50 software companies, only 10 are non-United States companies (CBR Research, 1999b).

The dominant position of Microsoft, may be in jeopardy as a result of the recent court ruling by United States District Judge Thomas Jackson, who declared that Microsoft routinely used its monopoly power to crush competitors which was also collaborated and confirmed in the April 2000 United States District Court ruling by Judge Elliot Spitzer. Possible actions against Microsoft arising from the court ruling may result in: Microsoft being split up (horizontally or vertically); other companies being permitted to buy a license for Windows; the source code to Windows being licensed-out to other firms (France, et al., 1999). If the United States Government decides to pursue any or all of these actions, it will undoubtedly have a major ramifications on the whole industry.

As with the overseas expansion of computer hardware manufacturers, United States companies have led and dominated the overseas expansion of computer software and services firms. Of course, many hardware manufacturers were also software providers which followed the expansion of manufacturing production. United States firms also benefited from first-

mover advantages which supported their early international expansion (Steinmueller, 1995). Key expansion, though, did not effectively take-off in any substantial way until the 1970s, because of the inherent nature of computer software and services activity and its relationship with the client.

Table 2.1

World's Top 20 Software Companies: 1998-1999

Rank	**Company**	$ million*
1	Microsoft	19,747
2	Oracle	8,827
3	Computer Associates	6,206
4	SAP	4,829
5	Compuware	1,638
6	Peoplesoft	1,314
7	BMC Software	1,304
8	Electronic Arts	1,222
9	Cadence Design Systems	1,216
10	Novell	1,084
11	Parametric Technology	1,018
12	Network Associates	990
13	JD Edwards & Co	934
14	Adobe Systems	894
15	SAS Institute	871
16	Sybase	867
17	Misys	743
18	Autodesk	740
19	Baan	736
20	Informix Software	735

* Note: there are variations in year end dates used for turnover figures

Source: Compiled from CBR Research data (CBR Research 1999b, 22)

2.3 Domestic Production versus Trade and Foreign Direct Investment

Not only has overseas expansion come relatively late to the computer software and services industry, it also has a number of fairly unique though conflicting characteristics associated with it. Firstly, is the fact that Foreign Direct Investment (FDI) in computer software and services often comes *before* exports of computer services although (as Kozul-Wright and Rowthorn, 1998 note) the transfer of facilities abroad is frequently blurred and rarely follows a linear ideal type, because direct contact and interaction with the user is so critical in the development of many aspects of software activity (Brady and Quintas, 1991). Such close client interaction involving complex systems usually requires physical presence in

the market involved, rather than being handled by a local agent without sufficient expertise or capability in dealing with client problems.

Secondly, there is a marked difference within the computer software and services sector between packaged software supplying the basic level personal computer market and the more complex and bespoke services offered by systems houses. In the case of standard software packages, which require little interaction between the software provider and client, sales can be handled by direct export using agents. By contrast more complex systems work requires closer user interaction on-site with the client. The ratio of software professionals to clients for software packages is 1:1,000, but for custom software is 1:25 (Jones, 1994). Moreover, for turnkey work, the software supplier will have to physically send staff to work on-site. Where, one-off work is being developed for a new customer in a new market, a firm can complete the contract by sending out expatriate workers. If the market expands for this type of work, this arrangement will be dropped in favour of hiring indigenous workers. This arrangement is not necessarily inexpensive, even when setting up a unit in a developing country.

Where companies have outsourced their whole IT function, computer software and service firms will generally have acquired staff from the company outsourcing its activities and continue to keep them at their existing locations. Thus, by 1996 half of EDS' worldwide staff of 80,000 had been directly acquired through these IT outsourcing deals with customers. Within the extremes of the simple export of packaged software and the physical presence of outsourcing, there are activities that can involve more complex servicing arrangements. Source coding of system languages can effectively be undertaken from satelite locations away from the client as long as there is a team of software engineers who are good at interfacing with the client and can clearly go through the systems definition phase of project specification (see Table 3.1). Again, staff involved in the interface process may be able to conduct such work on an intermittent basis and can be based overseas. However, this arrangement can become expensive if it involves expatriate workers from developed countries working abroad over time periods of more than a few months in durations. By contrast, more long-term complex work may have to be based in the overseas market concerned. Nevertheless, the bulk of the actual work can be undertaken in a different country. This has enormous potential implications for developing countries in terms of being able to exploit the vast human skilled resources that many developing economies possess.

To what degree are overseas markets served by exports and how many are served by direct investment? Interestingly although much is made of the exports of software packages (and their lack of intellectual property right protection) most computer software and services activities are based on FDI. Thus, Petit (1998) using UNCTAD (1994) data demonstrates the United States economy in 1989, service exports derived through FDI transactions accounted for 12 per cent of foreign revenues where 54 per cent and 59 per cent accounted for R&D and test work and for legal services for the same year. Although this data is dated, at the very least care must be used in not placing too much emphasis on the direct export of software as the main delivery mechanism for serving computer software and services markets abroad (Howells, 1988).

The computer software and services industry is a highly dynamic and growing industry. Its phenomenal growth offers great opportunities for economic growth and

development. However, it has a relatively short history which is especially true in terms of overseas expansion. Such a short history makes determining patterns of future growth particularly difficult, including patterns of where future growth will be located. Despite the high growth rates and dynamic shifts in the fortunes of new and existing players, paradoxically much of the way it has been shaped in developed countries, over recent years, has been by way of constraints and barriers to growth (this is set to continue). However, it is these constraints in developed countries which provide remarkable opportunities for developing countries to participate in this high growth, high value-added industry, which is so pivotal to the knowledge-based economies of the 21st century.

3. INTERNATIONAL GROWTH IN COMPUTER SOFTWARE AND SERVICES

3.1 Globalisation of Computer Software and Services

The internationalization of computer software and services activity came late compared with the manufacturing industry and many other service activities. Only hardware manufacturers served international markets in the period up to the mid-1970s. However, by the end of the 1980s the international spread in the coverage of the industry had taken off. Packaged software was becoming more readily available and exported; more specialist systems and software houses were expanding and were soon followed by the major IT service outsourcing companies, for example EDS and Cap Gemini Sogeti. This was in turn replaced by the rise of more complete computer software and services ‘majors’, such as United States based Microsoft and Oracle Corporations.

This international expansion of the sector has been dominated by the major industrialized economies both in terms of demand and supply. In terms of demand it was estimated that OECD countries accounted for nearly 97 per cent of the world market in the early 1980s (OECD, 1985). There has been little change in this locational pattern. Similarly, in 1990, vendors of United States software and related services still dominated the global computer software and services market. United States firms accounted for 57 per cent of the estimated $110 billion world market in software and related services. Japan, France, Germany, the United Kingdom and Canada accounted for a further 37 per cent. The OECD together with Eurostat have produced recent, but more narrowly defined data on international trade in computer and information services for 1996 (Table 3.1), that clearly shows the pre-eminent position of the United States in terms of net receipts, but in terms of credits the United Kingdom, Germany and Spain feature strongly.

The growth and pattern of international trade has been reflected in the growth of cross-border collaboration and in merger and take over activity. In 1985 mergers and acquisitions reached $2.5 billion, many occurring overseas (OECD, 1989).

Table 3.1
International Trade in Computer and Information Services:
OECD Countries, 1996

Country	Credits ($ millions)	Debits ($ millions)	Net ($ millions)
Canada	1,233	588	645
Mexico	-	-	-
United States	2,798	287	2,511
Japan	1,222	2,443	- 1,220
Republic of South Korea	6	76	- 70
Australia	168	173	- 5
New Zealand	30	59	- 30
Czech Republic	28	22	6
Hungary	-	-	-
Iceland	17	2	15
Norway	52	149	- 96
Poland	28	135	- 107
Switzerland	-	-	-
Turkey	-	-	-
Austria	-	-	-
Belgium-Luxembourg	706	606	100
Denmark	-	-	-
Finland	888	615	273
France	509	482	27
Germany	1,594	2,379	- 786
Greece	362	55	307
Ireland	104	293	- 189
Italy	207	590	- 382
Netherlands	633	649	- 15
Portugal	32	79	- 47
Spain	1,279	975	304
Sweden	405	331	74
United Kingdom	2,296	1,667	629

Source: compiled from OECD/Eurostat (1999, 72-3).

3.2 Locational Trends and Patterns in Computer Software and Services

Over recent years much has been made of the relocation and new investment in computer services mainly in developing countries, which nonetheless represent significant repositories of scientific and technical capabilities. Such moves have long been heralded and are now starting to take effect. This process, in part reflects the "hollowing out" of such a service activity by redirecting not just routine activities overseas, as has often occurred in manufacturing, but also key research, design, programming and maintenance work overseas. The most cited example of a developing country that has expanded its software industry is that of India, one of the most impoverished countries in the world but with a substantial scientific and technical base, amounting to some 170,000 scientists, technicians and engineers (Balasubramanyam and Balasubramanyam, 1997a).

As the computer services industry has matured into industrial activity, it has gradually evolved from being a largely domestically-oriented industry into an international one. Unlike much of manufacturing industry and indeed other parts of business services, computer services have arguably been more national in focus and more resistant to pressures of "globalization". Key factors sustaining a national orientation in software production and that have acted as strong barriers to its wider internationalization are: public procurement, language, dominance of national hardware suppliers with the peculiarities of their own operating systems, national standards, certification, intellectual property rights and regulation and limited scale and geographical scope benefits.

These factors, which had previously allowed considerable advantage to domestic computer services are now increasingly being eroded (Gentle and Howells, 1993). In terms of public procurement, it is now harder for Governments to show favouritism in handing out contracts to indigenous software suppliers. Similarly the language barrier in the past has been a key factor sustaining national market segmentation within Europe especially in terms of software and programming difficulties. However, over time this will also become even less a significant barrier as key multinationals (both consumers such as Electrolux and producers such as Cap Gemini Sogeti) have adopted English as the corporate language. The move to open systems, together with the gradual abandonment of the policy of supporting "national champions" within the IT industry, has signified that national markets are tending to lose their technical identity and differentiation.

The adoption of more widespread, international software standards and certification procedures, often in safety-critical areas and associated with formal methods has encouraged software producers to standardize their software writing and products for a wider world market, whilst also allowing users to feel more comfortable about using non-indigenous suppliers (Tierney 1992; Bowen and Stavridou, 1993). A number of these standards have indeed specifically been formulated at a pan-national level by bodies, such as the European Space Agency. The emergence of wider process standards, such as the ISO 9000 quality standard, has also enabled corporate customers to deal with and trust overseas suppliers. The formation of cross-border legislation and controls covering such key areas as intellectual property rights is also beginning to have an effect on broadening the horizons of the industry. It has only been recently that major multinational customers have encouraged computer service providers to provide global services and support networks. However, these major

corporate customers are actively seeking a global seamless solution to their computing and software needs.

The computer services industry has been responding to the emergence of a wider pan-national and indeed international market. Key players have expanded aggressively across Europe and North America, in establishing national networks through the acquisition of smaller domestic firms such as the acquisition by Cap Gemini Sogeti of the United Kingdom services group, Hoskyns (Gentle and Howells, 1994). Much of this expansion pressure has come from the need to win lucrative facilities, management and software sales to multinational companies who want to have a global solution rather than relying on a number of domestic firms in each of separate national territories. Larger multinational computer service firms are also allowing specialization between national centres in terms of software development and generation, rather than seeking to maintain a whole set of software specializations in each individual country.

The emergence of new major international players in the computer service industry is also continuing the evolution of a “dualistic” structure of the sector within the industry (Howels, 1987). The continued buoyant generation of new firms and their rapid growth within many advanced industrial economies, such as the United Kingdom (Keeble, et al., 1991), does not mask the fact that major computer service companies are rapidly expanding by way of above-average domestic growth rates and through acquisition activities. Acquisition activities, not only includes the take-over of previously independent firms but also those operations that have been spun-off by industrial corporations or through the direct purchase of in-house operations which have not yet been externalized. There appears to still be a strong process of fragmentation, externalization and re-absorption in the industry, as the sector churns out computer service activities from largely “hidden”, non-market (and hierarchical) activities within major industrial corporations, towards more open, specialist market operations, that either remain independent or are acquired by the major multinational computer service firms in the industry.

Lastly, as regards the issue of location, relocation and concentration trends within the industry, there is evidence of an important shift towards a more decentralized pattern of computer service and software production. In the United States context, in particular, a number of major factors are encouraging decentralization. Traditionally, close proximity to prime users was key factor for computer service and software manufacturers although this locational factor is now decreasing in importance. This is associated with the growth in packaged software, improvements in software generation requiring reduced maintenance activity needing close ongoing contact with the user and by disembodied improvements, such as structured methodologies (see above), in the organization of software programme throughout the software ‘life cycle’. As a consequence, stages 2-6 of programme generation (Table 3.2) need no longer be in such close proximity to the customer and can be located elsewhere (Howells, 1987). Certainly Indian software companies now locating subsidiaries in key European and North American markets have adopted this “decoupling” strategy. Thus Mastek and Maars have set up front offices and development units responsible for first accurately gauging, identifying and specifying what customers want. With this information in hand, the bulk of the coding and programming work is then done in India. Final installation and maintenance of the software is then undertaken by the European and North American Units.

A general increase in the distance away from the customer base can be highlighted with: commercial software packages (such as Lotus and MS-DOS) - average distance now 3,000 miles; systems software (such as PBX telephone systems) - with distances of several thousand miles; and military software (such as for the Patriot and Tomahawk missile systems) - approaching 6,000 miles. In other software applications though, such as management information systems where customer contact is still important, distance between customer and provider can remain a few thousand yards.

The rise of the 'software factory' phenomenon also has location implications. The factory phenomenon already creates a spatial division of labour by the fact that the 'orientation' and 'planned' workers are the ones who maintain customer contact, whilst the 'programmed' workers are responsible for code writing at the factory. Many of these practices are now being applied to less developed countries in combination with improvements in terrestrial and satellite based telecommunication systems. The diffusion of such telecommunication systems in combination with the disembodied innovations in software development and generation (for example, by increasing software reusability and reducing the need for much on-site maintenance work through reduced error rates and better user requirement proving) have meant that computer service companies in less developed countries can maintain contact with lucrative client bases in more developed countries. Thus CMC, based in India, undertook its work for the London Underground supported by its connection with the Indonet network and its link to an international satellite system. Similarly, software engineers at BT-Mahindra joint-venture in Bombay developed software for a customer service information system for Singapore Telecom, linked by satellite to other BT-Mahrindra software engineers working on-site in Singapore. Although some computer service companies remain sceptical as to how far this de-linking can go and whether it is effective, certainly the spatial de-location and segmentation of the industry can offer substantial opportunities for lower cost software centres in India, East Asia and Eastern Europe to serve markets in the major industrialized economies of the world.

Many developing countries are seeking to establish themselves as low cost 'knowledge factories', working at wages 90-95 per cent lower than in Europe and North America (Crabb, 1995). In addition, Eastern Europe, China and parts of the former Soviet Union are also seeking to benefit from their low cost, but under-utilized, software skills to form collaborative links with western companies seeking cheap, 'offshore' software expertise. Thus ICL (taken over by Fujitsu in 1990) which has cut back much of its research, design and engineering functions in software development within Britain, now has some 1,700 employees working in Fujitsu-ICIM (which used to be part of ICL before its takeover by Fujitsu and which ICL still has a 36 per cent holding) in India. Similarly, two other European companies, Bull and BT with their separate ventures with Mahindra are using India as a low cost base to compete for European and United States business (Martin, 1992; Ramachaudran, 1992).

3.3 The Growth of Computer Software in Developing Countries

By the late 1980s and early 1990s, several countries began to emerge as significant software producers and some countries such as Ireland (Coe, 1997b) had made firm-in roads in the developed countries, but had little domestic software industry from which to base their expansion. Others came from the Newly Industrialised Countries (NICs) of East Asia,

including Singapore (Chin and Wang, 1989), Malaysia and the Republic of Korea (Wu and Chun, 1989; Lee and Lee, 1994). However, others began to emerge from developing countries, such as India (Heeks, 1996) and Brazil (Gaio, 1992; Prochnik, 1997).

In the developing world, India has been the most successful in establishing a major domestic computer software and services industry (Heeks, 1996; Bhatnagar and Madon, 1997; and Balasubramanyam and Balasubramanyan, 1997b). The Indian computer software and services industry has grown rapidly, in terms of its computer software and services trade. From virtually no exports in 1980, by 1994-1995 it had over $160 million worth of exports (Table 3.2) and its rapid growth continues. Between 1990 and 1998 exports have grown by over 50 per cent per annum. This trend is expected to be sustained. India is already a major producer of computer software and services worldwide and soon will be only second to the United States in terms of overall trade activity.

Table 3.2
Indian Software Exports

Year	Net Exports ($ million)
1980	1.4
1981	2.4
1982	4.7
1983	6.4
1984	8.9
1985	9.7
1986	13.6
1987	18.9
1988-1989	24.4
1989-1990	36.9
1990-1991	45.9
1991-1992	60.9
1992-1993	76.9
1993-1994	109.9
1994-1995	168.3

Source: Heeks (1996)

4. COMPUTER SOFTWARE AND SERVICES AND DEVELOPING COUNTRIES

4.1 Introduction

It is important to recognize that although there are substantial differences in size and growth of the computer software and services industry between developed countries and developing countries, there are also substantial variations in computer software and services growth between developing countries. The emergence of NICs, such as Singapore and

Malaysia, although important in national development and policy terms, have not received the recognition of India as a software and services centre. A number of other developing countries are now seeking to emulate India's computer software growth strategy. However, the question remains: what factors led to India's success and are these factors replicable for other countries to follow? These issues will be explored after a more detailed appraisal of India's software development.

4.2 India: Factors of Success

India is seeking to further expand itself as a major software centre. Two United States companies, Novell and Oracle, are of the most recent foreign multinationals to set up design centres in India. The software explosion, centred on Bangalore (known as India's 'Silicon Plateau' and 'Surf City') has occurred by way of three main routes, that are briefly outlined below.

Firstly, computer companies forming joint-ventures (although sometimes running independent operations) with local Indian software companies, such as Tata Consultancy Services (TCS) and Wipro, to run software design centres has hastened the explosion. Other examples of such operations include Mahindra-British Telecom (employing 500 staff), Tata-Unisys and IBM-Tata. More recently, with the easing of FDI legislation in India, overseas multinational computer service companies have set up software centres in their own right. Microsoft has set up a new 50 acre facility in Hyderabad's High Tech City (India now accounts for over 10 per cent of Microsofts world wide workforce of 20,000 employees). Baan has also recently established a software development centre in Hyderabad.

The second element of the explosion has come from major industrial corporations which have set up sophisticated offshore development operations to generate software largely for their own use, but sometimes for resale. For example, Mahindra British Telecom gained 85 per cent of its turnover from British Telecommunications in 1998, but this proportion is declining (Guha, 1998). Examples here include: Citicorp, General Electric, Intel, Lucent Technologies, Motorola, Siemens and Texas Instruments.

Lastly, domestically-owned companies themselves continually garner increasing amounts of overseas trade. For example, CMC, a major Indian computer service company, has won contracts in overseas countries providing software for London Underground and La Suisse Insurance. More recently, Indian companies have started to set-up overseas subsidiaries in major developed economies. The United Kingdom has been a predominant base for Indian software companies seeking to expand into Europe. Mastek, for example, has set up a subsidiary in Bristol which employed 250 people in 1999 and had a 1998-1999 turnover of some £14 million. Similarly, Maars set-up its European operations in Berkshire, and together with its subsidiaires in the United States, Australia, Singapore and the Middle East, now employs over 300 people in these overseas units. Satyam also has a software development centre in the United Kingdom and four others in the United States and one each in Singapore and Japan.

These trade-oriented companies have displayed remarkable growth rates. The top twenty software firm exporters all recorded growth rates of more than 200 per cent between 1996-1997 and 1997-1998 (Taylor, 1998). Infosys Technologies, a top ten Indian software

exporter, was listed on the NASDAQ in 1999. Exports accounted for 97 per cent of the company's revenues in 1998 (Kazmin, 1999a). Tata Consultancy Services, India's largest computer software and services company (Table 5.1) alone hired 4,000 new software engineers in 1999. The employment growth potential of these trade-led companies should not be underplayed (Schware, 1995). Although cost may be an initial factor in basing operations in developing countries, these economies are now seeking to upgrade and develop their skills and move into more sophisticated high value areas of software generation and development.

4.3 Stages of Software Development Growth

India has had a profound influence on how stages in its software development had been conceptualized, as indicated by the four stage offshore development model. Yourdon (1992) has, for example, generated a similar, but wider 'stages of development' model (Table 4.1). Countries are seen as beginning with low value-added 'bodyshopping' and then start to evolve toward more autonomous offshore software customization and finally move toward more sophisticated package and product development. India moved from the first stage of maturity, (low value-added "bodyshopping") by the mid 1980s and by the late 1980s had evolved to more customized on-site development work (although even by 1990 most of its software exports were still based on these types of software services, unlike many other emerging software producing countries−Table 4.2). By the mid 1990s, India evolved to the third stage of software maturity by building software products for overseas markets. (Bhatnagar and Madon, 1997).

There remain two overriding problems in any discussion regarding the stages and models of software development growth in developing countries. First, as there are a lack of countries in similar situations, there is also a lack of historical data that can be used to explore whether the models or stages of development in software generation are actually well-founded. Excluding the NICs of East Asia, in reality only India, Brazil and possibly Chile have similarities of which to formulate comparisons. Even these comparisons may not be reliable, as India, which has developed the most, has only really just begun to develop past the initial specified development stages.

The second problem is that observers appear to always treat the development and export of new packaged software as the ultimate pinnacle of development. The following three main stages of software export development have been discussed (Correa, 1993b):

a) Export of labour, e.g. onsite services;
b) Export of services. e.g. offshore work;
c) Export of products, e.g. package export.

While the path that a developing country follows, as regards computer software and services development, is frequently laid out, in reality such a development path is neither clear nor straight forward. While it is relatively easy to see areas of the computer software and services which are routine and low value added (which developing countries should seek over time to move out of*)*, it is much harder to outline how and in what areas a country should seek to move into in the future. In turn, answers to these questions depend on the unique set of capabilities of the country concerned as there will be no universal 'best practice' template from which developing countries can choose.

4.4 Constraints and Opportunities

Despite the many attractions to developing countries, the computer software and services industry has had a very low profile and has been largely ignored by policy-makers. This trend has recently started to change. The development requirements of the industry, despite the fact it is a high technology, knowledge-based industry, centres on long-term, time-consuming and difficult measures that involve creating a sound institutional and educational frameworks that are effective at a local scale not on expensive, technocratic schemes. This effort usually requires "joined-up" Government schemes working together and requiring proficient organizational abilities. Without these local cross-cutting proficiencies and strategic focus, many of the other potential barriers will simply not be addressed.

There have been a wide range of studies examining the impact of information and communication technologies (ICT) on economic development (see Antonelli, 1991; Nagy, 1994; Avgerou, 1998; Bedi, 1999). The provision and spread of ICT networks and the Internet remains at a very low level in many parts of the developing world. However, the nature and size of the information and communication technology infrastructure, specifically the telecommunications network, has had a more direct impact on the growth and spread of the computer software and services industry. The computer service industry has come to increasingly rely on high-speed telecommunication networks and the Internet to transfer code, data and information across borders. Indeed difficulties in both verbal and data communication were considered to be the most important disadvantage in a survey of global information technology sourcing. Without access to fast and low cost ICT networks, the computer software and services industry will be constrained. Broadband/ISDN networks which can handle the data traffic associated with such data and Internet traffic are restricted in most developing countries, thereby restricting Internet use. However the situation is changing rapidly on ICT provision. In Pakistan there were only 80,000 Internet users in 1999 (Baqai, 1999), but the telecommunication infrastructure is rapidly improving. In many other developing countries, computer usage and Internet access has increased significantly. For example, 30 per cent of Chile's computers are Internet connected. Similarly, India's very low level of computers usage in the early 1990s, rapidly grew by some one million Internet users by 1999 and is estimated to grow by an additional 5 million by 2001.

The pool of scientific and technical professionals available in developing countries and its power as an attracting force in software development should not be underestimated. It has been estimated that India has the second largest pool of English speaking scientific professionals in the world; second only to the United States (Nasscom, 1999). Moreover the workforce is young. Although, the median age of Indian software developers is 26.2 years. Half of this software professional workforce has over five years work-related experience. India, alone, is adding 67,000 new software professionals to its workforce each year (Bagchi, 1999). Many other countries in the developing world have similarly large reserves of untapped scientific and technical workers. The skills required range from low skill occupations, such as data entry work, to more skilled activities involving source code generation and basic, entry-level programming work, to more advanced skills associated with leading-edge software and web-based work. There is a large manpower gap in the global software industry and these pools of scientific and technical labour remain ever attractive to computer software and information technology firms. However, as noted below, by no means

do all developing countries have an education system capable of turning-out suitably high levels of semi-skilled software workers. Even in India, where training programmes are extensive, few colleges outside the main six Institutes of Technology can offer more than basic programming training (Kazmin, 1999b).

Table 4.1
Stages of Development in the Software Industry

Stage	Objective	Description
1.	Build reputation	Low value-added body shopping
2.	Onshore to offshore	Offshore customized software development
3.	Improve value addition	Starting up offshore package development
4.	Product development	Total offshore product development

Source: Yourdon (1992)

Table 4.2
Software Exports of Selected Emerging Countries: 1990

Country	Proportion of Exports in Each Subheading (in percentage)		
	Software Services	Software Packages	Data Entry
India	90	5	5
Ireland	65	21	14
Mexico	53	32	15
Hungary	49	59	1
Philippines	39	20	41
Singapore	25	58	17
Israel	19	76	5
China	17	56	27

Source: World Bank (1992)

The national education system, particularly further and higher education, is crucial in generating skilled professionals suitable for software and computer service activities. Basic funding and information technology can still remain a problem, despite the provision of sophisticated software training programmes. For example, the University of Nambia had only 15 computers for 2,000 students (Wresch, 1998). Similarly in Mozambique there were only two organizations, (Centro de Informatica Universidade Eduardo Mondlan and EXI Lda), that provided semi-professional information technology education in 1996 (Werner, 1996).

The most obvious obstacle developing countries encounter in establishing a successful computer software and services industry is lack of financial capital. This is most evident in the number and distribution of computers within developing countries and more indirectly to the availability and cost of advanced telecommunication services. To be able to participate in software development and the provision of computer services requires, not surprisingly, access to a computer, whereas the diffusion and availability of computers in developing countries still remains low. Buying a computer would cost the average Bangladeshi more than eight year's income (compared with just one month's wage for the average American (UNDP, 1999)

However, the above cost-related problems also represent important opportunities for the initial development of the industry. A study revealed a key factor in outsourcing information systems work overseas was due to cost reductions associated with lower salaries (Apte, et al., 1997). The importance of low labour costs has also benefited the growth of India's software industry, although India's cost advantage over other low cost countries is narrowing. On average, Indian software engineers earned about $400 per month in 1997, which is still a tenth of the wages of their United States counterparts (Balasubramanyam and Balasubramanyam, 1997a).

India has undoubtedly benefited from an Anglophone, low-cost skilled workforce. The industry itself, but also the Internet in terms of websites and online databases, is dominated by English. The predominance of English can create major barriers for countries where English is unfamiliar. Language capability is important not only in terms of communicating with key clients, but is also crucial for the success of a good computer programme (Correa, 1996). However, the importance of language is not a pre-requisite; Chilean software companies have benefited by offering clients in Latin America programmes in Spanish and have indeed been protected by being outside the English-dominant software formats.

The debate about the level of intellectual property right protection afforded by countries and their level of development in terms of high technology industries has been going on for many years (UNCTAD, 1975, 1998, 1999). A recent World Bank study of more than 80 countries found that the effect of intellectual property rights on trade flows in high-tech goods was insignificant (UNDP, 1999). Similarly, another study found that the strength of intellectual property protection did not appear to be significantly related to R&D investments (Kumar, 1996). This can be explained by the type of R&D undertaken in developing countries which is less sensitive to the strength of intellectual property protection provided (thus R&D based in industrialized countries may be more creative or new product development oriented, hence demanding a stronger intellectual property regime), (Kumar, 1996). Great care needs to be taken in implying causality between intellectual property right

protection and development of high technology sectors, such as computer software and services, or in terms of presenting uni-dimensional or uni-linear patterns of development in high technology activity.

Much has already been discussed concerning India's development pattern based on export-led model software development based on 'body shopping' and source code generation. The Indian model of software development is frequently contrasted with the more domestically-oriented Brazilian model. Brazil first started to develop a national computer industry in the early 1970s based largely on market protection. However, in 1992, the Government adopted a more open policy, through the SOFTEX 2000 programme, which placed more emphasis on software rather than hardware computer production. The SOFTEX programme, influenced by the Brazilian academic community sought to improve the competitiveness and responsiveness of the computer services industry (Prochnik, 1997). The initial budget of SOFTEX was $38 million and was partly financed by the United Nations Development Programme. Although the programme has supported overseas trade by the Brazilian software industry, this is not necessarily its sole or even main goal. Certainly, the export and trade of computer software and services by Brazil remains comparatively low, although the computer service sector is seen as better integrated and suited to meet the needs of Brazilian industry. In part, this relates back to the earlier policy of developing an indigenously-owned hardware industry which sought to develop a basic "Brazilian" system software. This policy in turn provided some 'natural' protection to the domestic software industry which otherwise would have been more threatened by overseas competitors (Schware, 1992).

By contrast, what may be termed the East Asian software development model of NICs, has been seen to adopt a more supply-led and export-oriented, industrial policy based programme of computer software and services support. In Singapore the sector has been supported by a liberal programme of infrastructure spending on ICTs (Chin and Wang, 1989; Chia, Lee and Yeo, 1998; Newlands, 1999). This has also been copied by Malaysia and Thailand (Pooparadai, 1999). Thailand, for example, is creating Phuket as an 'intelligent island' which will attract software developers to set up computer service companies on the island. In the Republic of Korea, development of the industry has been supported by R&D programme funding and through Government demand stimulation, by way of the establishment of large public information projects (Wu and Chun ,1989; Lee and Lee, 1994).

Another country which has actively sought to stimulate the growth and development of their software industries is Chile. Chile has emerged as the main software exporter in Latin America. Chilean software companies have set up overseas subsidiaries in a number of major Latin American countries, including Argentina, Columbia and Venezuela. It has been suggested that this expansion has been aided by Chilean companies not seeking to compete against English language programmes, but instead to provide packaged and bespoke software that meet the especial needs of local Spanish-speaking industries. Certainly Chilean software companies appear to have been successful, with exports mainly focused on the Latin American market growing rapidly in the early 1990s (accounting for 57 per cent of total exports in 1992). Chilean trade was largely based on packaged software, in contrast to that of India (Correa, 1996).

China's policy focus has been largely on producing one of the world's largest electronic hardware producers. The Government has particularly focused on developing its semiconductor industry and since 1995, China's state owned chip companies have produced more than 350 million integrated circuits (ICs). Since 1996 new guidelines have been introduced to encourage foreign participation in the computer and electronics industry (Mathews, 1996). By contrast, policy interest in computer software and services has been much lower and has largely been a facilitating role in relation to the development of the hardware industry. Currently, this is changing, as sales of personal computers increase in China. This has resulted in a number of small, independent developed country companies seeking to adapt overseas commercial packages for the Chinese market. However, there is an absence of a fully articulated policy towards the development of computer software in China. China's entry into the World Trade Organization could have a major impact on its IPR regime.

It is difficult not to focus on India's success and promote it as a 'best practice' model for other developing countries to follow. However, as this chapter has highlighted there are many factors associated with India's success that may be difficult to emulate. Moreover, India's development pattern is not necessarily what other countries would necessarily wish to adopt, even presuming they had similar economic profiles. Other countries have been relatively successful, but have followed different development paths such as Chile and Brazil. Chile and Brazil are examples of countries adopting distinctive and independent development trajectories as regards software and computer services activity. However, developing countries need to be flexible in their policies in order to pursue development paths suited to their own specific requirements and capacities, that may vary significantly from those of India.

Firstly, in choosing a national technology strategy, it is important to recognize the different capabilities and requirements of developing countries. Policy diversity that meets the specific needs of the country concerned is strongly recommended. This should be based on the different capabilities of the countries concerned, as well as on their individual aspirations. Secondly, as regards the issue of "joined up" policy; providing a good "seedbed" for the growth of computer software and services, may not need vast financial resources, but it does require both good horizontal coordination between different government departments (such as education, telecommunications and industry ministries), and agencies and vertical coordination between these organizations and local institutions and firms "on the ground". The linking up of different levels and agencies in terms of "governmental interdependence" is important.

Thirdly, regarding the need for localized policy learning, getting things "wrong" in terms of policy and strategy is not necessarily a bad thing as long as lessons are learnt. Governments should not be timid to alter policy if it is not succeeding or in need of change to meet changing circumstances (Brazilian information technology policy is a case in point here). This notion of flexibility and learning required in policy-making relates to the need for the development of local knowledge institutes and experimentation or 'local social discovery' (Stigilitz, 1999). The computer software and services industry is undoubtedly a sector that requires a great deal of social learning and experimentation prior to effective policy formulations.

5. INTELLECTUAL PROPERTY RIGHTS AND THE COMPUTER SOFTWARE AND SERVICES INDUSTRY

A key problem for the computer services and software industry is that whilst many of the products and services they produce are costly and often pose a financial risk to develop they are also easy to copy. Ease of copying creates major disincentives to develop new and innovative software programmes, hindering the development of individual (innovative) firms and the industry overall. Certainly, computer software and services firms can develop strategies which do not wholly or substantively depend on the protection of intellectual property rights legislation, although most do depend on such legislation, particularly as a last resort and as a framework from which to build up an overall protection strategy. It should be recognized that not all aspects of the computer software and services industry are affected by copyright and piracy problems. For some computer services, such as maintenance activities, copying is not a problem. This is the case for custom made computer software writing, where a specific problem requires a specific solution and adapting this solution to fit another user context can be expensive, difficult and in many cases fruitless. Moreover, the consumer has little or no incentive to share the knowledge associated with the activity because those who stand to gain most are likely to be its competitors.

There have been two parallel developments associated with intellectual property within the industry: First, there has been a strengthening of intellectual property rights protection afforded to computer software. Second, there remains the issue of unlawful software copying which has become technically easier over time, but which may become more difficult with new encryption. Enforcement of intellectual property right legislation in many countries remains very weak or non-existent.

5.1 Computer Software and Services Intellectual Property Rights Regimes

In the 1970s, a number of developed countries started to introduce legislation which sought to protect aspects of intellectual property relating to computer software. However, it was not until the introduction of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement first came into effect in 1996 that a more harmonized approach toward intellectual property began to be realized.

5.2 Trade-Related Aspects of Intellectual Property Rights

The types of intellectual property covered by the Agreement includes: copyright and related rights; trademarks; industrial designs and layout design of integrated circuits; and patents. The TRIPS Agreement has three main features: standards, enforcement and dispute settlement. In relation to standards, the Agreement sets these by requiring that the most recent versions of the substantive obligations of the main conventions of the WIPO, the Paris Convention for the Protection of Industrial Property (Paris Convention) and the Berne Convention for the Protection of Literary and Artistic Works (Berne Convention), be complied with. In terms of enforcement, the Agreement lays down generally applicable rules of all intellectual property rights enforcement procedures. It also broadly outlines the available procedures for rights holders to effectively enforce their rights. Under disputes arising within the terms of TRIPS Agreement and obligations, all WTO members are subject

to the WTO's dispute settlement procedures. For the first time, the Agreement set out minimum standards of protection which all members to the TRIPS accord adopted. The Agreement also laid out provisions for the domestic enforcement of intellectual property rights covered by the accord. In turn, disputes arising under the Agreement are to be settled by the WTO's dispute settlement procedures.

In relation to copyright, TRIPS Agreement went further than the Berne Convention which provided generally basic standards for copyright protection, by improving the levels of protection under the latest act under the Convention, the Paris Act of 1971. The TRIPS Agreement therefore clarifies and adds certain elements to the Berne Convention (1971). Thus, it confirmed that computer programmes are protected under copyright as well as to those provisions of the Berne Convention applying to literary works (Article 10.1). Moreover, it noted that the programmes form, whether it is source or object code, does not affect the level of protection afforded to it. It also confirmed that the general term of protection of 50 years applies to computer programmes (more specifically, the term shall be no less than 50 years from the end of the calendar year of authorized publication, or, failing such authorized publication within 50 years from the making of the work, 50 years from the end of the calendar year of making).

Article 7 of the TRIPS Agreement is worth noting here. This article holds that the protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology. This should be to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare and to a balance of rights and obligations. Further changes to TRIPS are currently under review in the World Trade Organization (WTO) that include discussions on filling in gaps in intellectual property protection not covered by the existing TRIPS and on measures which will take into account issues raised by new technological and other developments. Clearly, many developing countries are not going to meet the original deadlines that were laid out under the TRIPS Agreement—they evidently require more time. The original transitional period was too short and developing countries simply did not have enough time to comply with the commitments. Many developing countries feel that TRIPS is not in their favour and have deep concerns that the wider economic and social issues that were in the original Agreement. Moreover, if the protection of intellectual property is taken too far, it may limit creativity and free competition within markets (Quéau, 2000, Correa, 2000). When extending intellectual property rights, consideration should be given to other (fundamental) rights, such as access to information, freedom of expression and the acknowledgement of social justice (Quéau, 2000).

5.3 Strategies to Protect Intellectual Property in Computer Services

Although intellectual property rights protection is important for software firms seeking protection under various intellectual property rights laws, it is not the only mechanisms to avoid appropriability of their intellectual property. There are a number of other strategies which computer software and services firms can turn to, in addition to, or as a substitute for, intellectual property law (Howells, 1997). These are:

- *Secrecy:* Some argue that the best intellectual property rights' strategy for an innovative service firm is secrecy, or "secret know-how" (Taylor and Silberston, 1973). How far

secrecy can be sustained in the computer software and services industries is questionable given that much (packaged) software can be simply reversed engineered.

- *"Ensemble" Protection:* This, in a sense, is not a substitute for using intellectual property rights legislation, rather it seeks protection through novel ways by combining different types of intellectual property rights to provide protection for a new service product. Thus, software firms may consider protecting their innovations through an ensemble of intellectual property rights methods, for example using trademarks with patenting and copyright to protect a piece of software.

- *Short Innovation Cycles:* By seeking to create ever shorter innovation cycles a firm can reduce the risk of copying and imitation by reducing "lead times" by such a factor that by the time a potential competitor does seek to copy or imitate the innovation, it is too late. Significant barriers to imitation are created by such action. Innovation cycles in the software industry are often less than six months. This is particularly true where regular updates are required and are "natural" for the purpose, for example, with computer virus programmes which need to come out regularly over short periods to keep pace with new viruses and trojans. However, short lead times impose considerable costs to a firm and more specifically means that innovation costs will need to be amortized over very short periods.

- *"Firmware":* There was much discussion in the 1980s that intellectual property protection for computer software was so weak that firms sought to protect their software by embedding it in microchips, coining the phrase "firmware" or more formally "embedded microelectronics software." A variety of methods exist for incorporating the software (the "micro-code or micro-programmes") in the electronic circuit, although a significant proportion of software is protected this way, if only because all microprocessor systems must by definition incorporate their own control programme (OECD, 1985). Interestingly, although such micro-code may be harder to copy, in the United States such code still falls within the meaning of "computer programme" (Bainbridge, 1996).

- *Standards:* A major factor that helps protect software companies is the creation of separate standards on which their software run. This can be a double-edged sword in the sense that to be truly successful, software companies need other third-party companies to accept and develop applications software to run on their system software, by controlling the operating standards the software is based on. There is a danger that the standard setting software company can lose control of the standard it creates and therefore lose the power that is involved with standards setting in terms of determining the framework and conditions of software being developed that is based on that standard. There is also the other danger of being seen as wielding too much monopoly power if the standards become too dominant, as with case of Microsoft with its Dos and Windows systems used as the de facto operating standard for IBM-compatible personal computers (Chandler, 1997).

Obviously, even these strategies are not independent of each other. Standards combined with short innovation cycles may offer substantial protection to a computer services firm (Metcalfe and Miles, 1994) and may be a preferred strategy over more formal intellectual property rights methods. However, in turn, these strategies when combined with

intellectual property legislation can provide quite powerful protective mechanisms for computer software and services companies. Nonetheless, this still requires the effective enforcement of intellectual property rights legislation which remains weak. One advantage that service firms reliant on the copyright system for intellectual property rights protection have over manufacturing companies that are dependent on the patent system for intellectual property protection, is that they are not obliged to register the copyright; rather, only activate it when they see is being transgressed. In this manner, they do not alert potential competitors to new technologies they are developing (unlike patents which stipulates in the public domain the precise technical information about the product, process or molecule that has been registered).

5.4 New Dimensions to Intellectual Property Rights

Adjacent to the introduction of TRIPS and the development of new corporate strategies regarding the protection of intellectual property, there have also been new developments in the generation and delivery of software and new legislation that has changed the balance and context of intellectual property rights within the industry. One such key development is the prospective shift away from "packaged" software downloaded from physical disks, CD-ROMS and digital video disks (DVDs) to software that can be downloaded from the Internet. Some software has, for a time, already been sold on-line in the form of access fees. With the rise of the Internet packaged software could be rapidly replaced by on-line distribution (Hardy, 1998). Currently, software consumers often purchase physical software packages, but purchase updates and "patches" over the Internet. Third-party update services can provide new versions of software to a consumer by programming the person's computer to regularly "check-in" to a centralized database for updating and installation. A further possible option is that software capabilities will not be physically held on the user's computer, but will be "downloaded as needed" with the computer downloading small applications, "applets" at the time they are required (Hardy, 1998). Such applications may be usable for a limited time period or may be deleted when not used for a certain period of time.

This model for computer development mirrors what currently occurs with applications based on the "Java" computer programming language, where Java programmes are currently downloaded via the Internet. However, this prospect is in part based on the wider vision of "thin-client" computing where the computer is basically an intelligent terminal or network computer (NC). NCs are little more than a processor chip with a terminal linked through a network cable to a server computer. The server houses the thin client's operating system and application software, as well as the files belonging to the user and the user's workgroup (Sheehan, 1999). Whether this trend of "thin client" computing continues to grow depends on the speed and cost of the Internet, on one hand, and on the other, whether developments in physical storage systems keep pace with the trend toward network downloading. If network downloading does gather momentum, it may shift computing toward a network vision which would leave economies with poor telecommunications at a further disadvantage in terms of computer software and services activity.

The issue of NCs and the growth of on-line software downloading, could potentially have contrasting implications for on-line software distribution. On the one hand, "thin client" computing suggests that software will be easier to control and protect as it becomes centralized on large server computers. On the other hand, on-line software distribution over

the Internet may make software copying and distribution more effortless by potentially further lowering the cost and inconvenience of making unauthorized use of copyright work. Certainly the development of on-line software distribution, as a form of "decentralized infringement" suggests that the increases in the amount of unauthorized use makes the identification and monitoring of the actors involved extremely difficult (Hardy, 1998). However, this potential trend of facilitated copying, will be offset by further developments in encryption technologies to guard against unauthorized access and protect software and data transmission. In other areas of on-line information and knowledge services, developments in producing "digital signatures" and "digital watermarks" offer further encoding mechanisms to protect intellectual property (Davis, 1998).

The growth of on-line software distribution in turn, raises further issues for intellectual property and copyright legislation seeking to protect computer software. Copyright legislation has done much to "catch up" with the predominantly manufacturing focus of the patent system. Nevertheless, copyright legislation will undoubtedly have to undergo further change in scope, to keep pace with technological developments and the changing framework in terms of how software is produced and distributed. Nonetheless, the real challenge will remain the monitoring and enforcement of whatever new legislative frameworks that are agreed. Tracking of physical packages is a difficult task but the tracking of software distributed, legally and illegally via the Internet, will become overwhelming.

A major new phenomenon for developing countries is the rise of essentially free software based on Linux-based software. The Linux system distributes many important applications such as compilers, networking software and firewalls for free. Linux provides the developing world access to the Unix/X Windows environment at essentially zero software cost (Bokhari and Rehman, 1999). Moreover, Linux can run on commodity IBM-personal computer compatible hardware, which is available at a fraction of the cost of comparable workstations. The Linux system is labour intensive in terms of set-up and configuration but, this is of little concern to developing countries with low labour costs (Bokhari and Rehman, 1999). In addition, access to source code allows increased flexibility by allowing for easy modification of software to suit local needs and requirements.

6. THE ROLE OF INTELLECTUAL PROPERTY RIGHTS IN THE DEVELOPMENT OF COMPUTER SOFTWARE AND SERVICES IN DEVELOPING COUNTRIES

6.1 Intellectual Property Rights and Software Development in Developing Countries

How significant is the issue of intellectual property rights in the development of the computer software and services sector and what links does it have with this development over time? Some of the more general studies covering intellectual property and economic and technological development previously cited suggest that its influence may be overplayed. Is this the case specifically in relation to the computer software and services industry? Most commentators believe that intellectual property rights are an important, but by no means the only factor influencing the development of a software industry in developing countries.

Some observers perceive intellectual property rights and software piracy more particularly, as steering Indian software suppliers away from the "packaged market" (Schware, 1992). While in Brazil, the increasing enforcement of intellectual property protection has made it a more desirable market (though not necessarily a production base) for software products. In reviewing software development in a number of countries, IPR regime is identified as a barrier to software companies from developing countries expanding overseas (Correa, 1996). Other observers consider software piracy as initially helping the expansion of computer use and of forming a wide base of software skills. Moreover, the benefits of adopting such a policy decline over the long-term and costs increase (Heeks, 1996). In the long-term, piracy "reduces the revenues and market size for local packaged production and must be controlled if that market and the local software industry are to grow" (Heeks, 1996). On the opposite side of the debate, there are those who consider intellectual property rights as a "critical determinant for client companies contemplating offshore software development within India" (Bhatnagar and Madon, 1997). This view is generally associated with consumer concerns over Internet security and secrecy.

The significance of intellectual property rights becomes more important over time, in relation to the software sector in developing countries. In the early stages of development of the Sector, intellectual property rights and software piracy are seen as negligible importance and 'negative' intellectual property right policies may be informally encouraged so as to foster the diffusion of computer usage and exposure to software. Over time, lax or non-existent, intellectual property rights legislation not only affects imported software packages produced by foreign multinationals, but also stifles the domestic software industry. Strong and coherent intellectual property rights legislation is particularly important for the production of packaged software (what many see as the ultimate goal of software development). If this is a desired development strategy, policy will have to change over time from a 'loose' intellectual property rights system to a 'tight' intellectual property rights platform.

A stylized growth model is based on an export-led development path. A more domestic-oriented software strategy, based on software as a 'facilitator' for other industries and the economy as a whole, will have a different growth pattern although in intellectual property rights terms, the problems will remain similar. Equally, a more industrial, infrastructure-led policy, characterized by many NICs, will have a tighter intellectual property rights regime to begin with in order to encourage inward investment by large foreign-owned software companies (see Table 6.1).

6.2 Low Intellectual Property Rights Protection

Software piracy was estimated to have cost computer service companies some $13 billion in 1996. As is oft quoted, "even before Microsoft launched Windows 95 at $100, it was on sale in Beijing for $9" (UNDP, 1999). Software firms have lost billions of dollars of trade through software privacy. Much has been made of software piracy by nations and software companies from the developed world. The problems stems from the ease and low cost of copying, especially in terms of packaged software. Although the industry as a whole is effected by important consequences, the effects of unlawful software copying on developing countries and the encouragement of a domestic software and computer services industry could be devastating.

Many protagonists would argue that developing countries should ignore intellectual property rights on software and turn their attention toward low intellectual property rights protection and enforcement of computer programmes and software packages developed abroad. Very large proportions of users in developing nations are simply incapable of paying the market cost of proprietary software. Moreover, piracy raises the total number of programme users, thereby widening the user base, which paradoxically may ultimately favour the software producer as it increases the overall value of the programme (Conner and Rumelt, 1991). For the least developed economies of the world, this is probably the only strategy available to them anyway, since proper enforcement can be extremely costly. For these poorest nations and those in the early stages of software sector development, an actual low level of intellectual property rights protection policy as noted above, allows for a more rapid diffusion of computer usage and greater exposure to widely available software (Heeks, 1996).

However, once a software industry (both domestic and foreign-owned) begins to develop in a country, "loose" intellectual property legislation and poor enforcement of such legislation can have damaging effects to the industry. Developing countries with foreign multinational software companies operating in their country can be severely damaged by low intellectual property rights protection for domestic computer software and services. For example, as noted earlier, India is now the base for over 10 per cent of Microsoft's employees and as such what is bad for Microsoft will also be bad for Microsoft employees' in India. In a development sense, low levels of intellectual property rights protection effectively removes the market for indigenously produced software, that is often much better suited to local industry and the broader development needs of the country. Wipro Systems and Sonata in India, for example, were effectively forced out of producing domestic "packaged" software for the Indian market. Low levels of intellectual property rights protection for software can also stifle export-led initiatives of domestic computer service firms. Small, domestic software firms simply do not have the resources to defend their products in overseas markets. Moreover, the most suitable (for both supplier and consumer) overseas markets to penetrate are often the markets of other developing countries.

However, other observers who do not share this view of proprietary software, note that it creates "new dependencies: it actively hinders self-help, mutual aid and community development" (Yee, 1999). In this context, possibilities for building local support and maintenance systems and modifying software to fit local needs are lost. Certainly, a more sensitive approach by developed countries to the problems and issues surrounding intellectual property rights in least developed countries must be adopted. Equally, a more realistic approach should be adopted by developing countries seeking to actively expand computer software and service activity and develop it into a leading industrial sector. Lack of an intellectual property rights regime covering software and computer services will retard the development of a successful industry. For most developing countries, intellectual property rights will become an issue that has to be addressed if the industry is to successfully develop its exports capabilities.

Table 6.1

Stages of Growth in Computer Software and Services for Developing Countries: One Scenario?

Stage	Description of Stage	Intellectual Property Rights Issues	Policy Concerns
Level 1	Minimal computer software and services industry presence in the country; what exists are a few sales/marketing outlets and some IT/software consultants.	High level of piracy of computer software	Policy focus on improved consumption especially in terms of cost and access (of cheap/free software).
Level 2	Establishment of sales offices by major multinational computer software and service companies; possible local adaptation of major programmes by MNCs; very small nucleus of domestic companies focused around software local consultancy and adaptation work and overseas bodyshopping.	High level of piracy of computer software; initial concerns being raised by domestic software producers.	Policy focus still on consumption but growing interest in developing a computer software and services industry (supply).
Level 3	More general inward investment by major computer service MNCs to access cheap but skilled labour; domestic software companies developing around the production of custom-made software, out sourced coding work and continued body shopping.	Clamp down on piracy to protect the industry begins mainly under pressure from overseas MNCs operating in the country.	Twin policy focus on FDI and domestic computer software and services development. Policy shifts more strongly towards developing the industry (supply) as part of economic development.
Level 4	Take-off of the domestically-owned industry still focused on custom-made software development; FDI by domestically-owned companies starts; continued build-up of overseas computer software and service; concern over increasing labour costs; growth in supporting institutional framework.	Ongoing clamp down on piracy and acceptance of international intellectual property regimes which will protect the development of the domestic industry.	Strong emphasis on computer software and services as sector for industrial policy.
Level 5	Full international 'player' status	Increasing attention towards global intellectual property right concerns	Global expansion, but good domestic provision

6.3 An Alternative Route to Software Development?

Little or no protection of intellectual property rights for software is, in one sense, a way of getting around the intellectual property rights problem. An alternative model that has potential is free software. Linux-based software and GNU system environment software together constitute an operating system that is an alternative to the Unix/X Windows based system. In addition, the large variety of tools and compilers available on Linux makes it relatively easy and cheap to teach computer science courses (Bokhari and Rehman, 1999).

Free Linux software has other advantages apart from its negligible cost (Yee, 1999). It is recognized as, in many instances, more reliable and robust than commercially available counterparts, due to its open development, implementation and testing. Lastly, users are not tied to single vendors when seeking software support, thereby avoiding issues of dependence and control. For many least developed nations, Linux offers the only legitimate and affordable mechanism from which to access adequate software capabilities.

There are many advantages that Linux and other free software programmes offer for many developing countries, but problems and issues still remain. Paradoxically the biggest barrier to the distribution and adoption of free software is the prevalence of pirated software in developing countries. Linux, for example, cannot match the "glitz" and glamour of pirated commercial software such as Windows. Indeed, Microsoft may benefit from software piracy as it may help in further popularizing Windows thereby generating a greater brand loyalty for potential purchases in the future (even though the users are not paying for the brand now). Moreover, the Linux software programme cannot be said to be totally "free" to use since it often requires expertise to use and adapt the software in the first place and requires ongoing computer support for users. Thus, Red Hat, the major United States-based Linux software group, provides a packaged version of Linux, source code and technical support service, which has proved extremely useful and popular, but is obviously not free. Regardless of all these issues though, Linux is here to stay and IDC predicts it will be the fastest growing operating system between 1999 and 2003 (Hughes, 1999).

However, more fundamentally, the issue of free software raises the question of how Governments in developing countries view software and computer services. Is software and computer services seen as just that, a 'service' to other parts of the economy and society? Or is it seen (now or in the future) as a strategic industry to be developed? This policy dichotomy for developing countries, especially least developed countries, revolves around two alternative policy perspectives. Firstly, whether the activity is seen as a potential economic powerhouse leading to the generation of new jobs and industrial growth based on developing proprietary software "*supplier creating*". Or, secondly, whether it is perceived as part of strengthening the wider economic infrastructure to support other parts of the economy or society based on free or non-sanctioned pirated software "*user-driven*". If the former policy of "*supplier creating*" is adopted, intellectual property rights legislation and enforcement measures covering computer software and services will have to be set-up to protect the proprietary software being developed by the domestic sector and by foreign multinational software companies that have been attracted into the country.

For the second, "*user-driven*" strategy to be successful, development and access to free software based on meeting local computer software and service needs will be the

priority. This policy option will sacrifice the possibility of developing full-scale computer software and services industry aimed at establishing a low cost, user-oriented and user-friendly network of software activities. It is important to recognize that expertise, skills and personnel will not reside in an identifiable industry as such, but will largely be hidden amongst user firms, organizations, public agencies and government departments. This computer software derives its strength through its widely distributed nature, that is closely integrated and suited to user needs. A drawback though is that there will not be a readily identifiable industry seeking to proactively extend and grow the industry for profit. Incentives for expanding a user-driven software policy based on free/cheap software will have to depend on the users themselves and in turn the Government and other non-governmental organizations (NGOs) seeking to stimulate these users to adopt and develop such software to meet their computing needs.

Which of the two policies should be adopted by a developing country? Both strategies have appeal and previously as noted, much depends on what policy-makers want. The development of a commonwealth of free Linux type and cheap software based in turn on reciprocal exchange, dialogue and support closely linked to economic and social needs obviously has strong appeal. However, the economic appeal of an industry based on proprietary software making “good”, as in the case of India is also strong. This latter strategy offers one of the few routes (because of low capital entry barriers) a developing country may have in generating a high value, knowledge-based industry that can rapidly be involved in economic transactions on a global basis.

However, in reality, the pursuance of either strategy will involve difficulties before it is achieved or sustained. Few developing countries have successfully implemented a “supplier creating” strategy. Similarly the “user-driven” option will also be a difficult route to follow. It will need strong and ongoing stimulation and financial support from Government and NGOs to sustain domestic software development. Without proactive support, the likelihood of indigenous software development is put in question.

7. FINDINGS AND POLICY IMPLICATIONS

Policymakers from developing countries need to consider computer software and services as an important policy opportunity for the following reasons:

- The industry is a high growth sector, both in terms of industrial turnover, output and employment;
- There are relatively low entry barriers to the industry, particularly in terms of financial and capital requirements;
- As such, it represents one of the few opportunities open to developing countries for participating in a high technology, knowledge-based industry;
- In turn, the industry represents an important element within the knowledge infrastructure of a modern economy; it provides an important underpinning and facilitating role for other parts of the economy;
- Correctly supported, the industry provides considerable opportunities for export trade and ultimately overseas foreign investment;

- In addition, the industry has the potential to offer the full range of skill demands; from low skill, data entry jobs to high skill sophisticated programming work.

7.1 Barriers

Which barriers and constraints exists for policy makers?

- Being able to develop and build the industry depends on having an education system that can provide some basic, entry-level training to the potential workforce;
- It requires the identification, through a basic mapping exercise, of a core reservoir of computer software and services activities and personnel from which to build a wider participant and industrial base.
- Many of the potential attractions stem from being able to develop and upgrade past the initial, low skill-based software activities;
- This, in turn, is associated with the ability of domestically-owned companies to tap into and serve sophisticated overseas clients based in the main advanced economies of the world;
- Above all, the development of the industry requires commitment in terms of coordinating the wide multiplicity of agencies and institutions, both vertically and horizontally, to deliver the right environment for the industry to prosper and grow. Policy intervention requires adequate linking and inter-facing and social learning processes for it to be successfully delivered on a local scale.

7.2 Options

Although intellectual property protection is only one factor in the successful development of computer software and services in a country, it is important to explore the opportunities provided by the availability of free software founded on, among other things, Linux-based platforms. The opportunities this option provides for developing countries has been described as "*user-driven"* strategy. Adopting the option of software development within a country based on using and adapting "free" software, however, does not come without costs. It could potentially foreclose the development of a more focussed industry by removing an effective market for software, whether domestically or foreign based. The "*supplier creating*" strategy, however, also does not come without costs or problems. Its early stages of development suggests a more export-based strategy and it creates the danger that the needs of the domestic economy will be effectively neglected over the initial period of development.

It would also be misleading to suggest that the two policy strategies are the sole policy alternatives available. Another option could be the blending of the two policies with a shift in emphasis over time from one strategy to another. A "user-driven" strategy may be initially adopted before gradually replacing it with a "supplier-creating" policy. In summary, three main policy options as regards development of computer software and services are provided. They centre on whether to:

- Adopt a "*user-driven*" strategy which is based on the availability of free Linux type software and its adaption, dissemination and use tailored to the demands of the domestic economy and society. This may be better suited to the needs of local industry but could foreclose on the wider benefits of export-led growth and development;
- Follow a traditional "*supplier creating*" strategy which seeks to develop commercial, proprietary software in part driven by overseas customers through an expert-led development path;
- Adopt a possible combination of the two options, focusing initially on a user-driven strategy, but over time introducing a stronger commercial, supplier creating framework.

Each policy option has its strengths and weaknesses. The low cost, potentially well integrated nature of the "user-driven" option and the opportunity to access high growth, high value knowledge based activity associated with the "supplier creating" policy. Lastly, for any policy to be successful, it must be properly set-up to match the needs and capabilities of the country concerned and not involve the adoption of standard "best practice" mechanisms, which may have only passing relevance to the particular circumstances of the economy being considered.

7.3 Further Research

More detailed policy review, appraisal and analysis of the impact of intellectual property rights on computer software and services development within developing countries is hindered, owing to the dearth of basic information relating to the current status and prospects of software development and trade within these countries. With the notable exception of India, basic data and information on the industry remains sparse, particularly in the developing world. Further research, through detailed case studies and applied work, needs to be undertaken in those countries where interesting development patterns seem to be occurring, for example, in Argentina, Chile, Costa Rica, Jamaica, Sri Lanka, Thailand and parts of the West Indies. The continued lack of computer software and services development in Africa and other least developed parts of the world, however, also needs to be explored. Some least developed countries barely register in terms of computer and software use, let alone development, with major barriers to software development remaining in place.

Such research needs to be undertaken within a more specific analysis of intellectual property rights issues, as a factor in software development within developing countries. Most discussions about technological development within the software industry are undertaken largely within the context of the developed world and technological leaders. Little, if any, analysis has been undertaken from the perspective of developing countries.

8. CONCLUSIONS

Over the last two decades, the computer software industry has been experiencing high growth rates and the increasing international spread of computer software and services. Although it is far from universal, this sector has the potential to be one of the most

internationally dispersed high-technology industries in the world. Computer software and services activities hold vast opportunities for developing countries primarily due to low capital entry requirements as well as the industry's high value, high growth nature and the high technology, knowledge-rich profile of software activities. Above all, although developing countries face barriers in the establishment of the industry (especially least developed countries), they hold a number of notable locational advantages. Up to now, only a few developing countries have as yet moved into more mature indigenous growth and development patterns. Nonetheless, the industry provides almost unique and unparalleled opportunities for the wider development and growth of developing countries, which should not be ignored.

Intellectual property protection represents an important factor influencing the development of the computer software and services in the developed and developing world. However, IPRs is not the only factor in terms of shaping the industry's development and often has an indirect impact in terms of how it influences other key factors affecting the development of the industry. The very fast pace of technological change within the industry, itself signifies that intellectual property rights legislation has to continually adapt to and reflect, these changes in IT technology. Although IPRs legislation in many parts of the world has by now been implemented to cover the protection of intellectual property in the industry, enforcement remains difficult. For example, LDCs cannot be expected to fund the high cost of enforcement from their own budgets and will require support from international community in this endeavour. Of all developing countries, India has been by far the most successful in terms of establishing its software industry, however, its own uniqueness raises replicability problems. To date, very few developing countries have gone beyond the early stages of development—diverse contexts and prospects for development call for bold, new strategies. Comparisons are difficult and success factors (as well as barriers to development) for individual countries may be substantially different. Difficult policy decisions need to be considered carefully prior to jumping to easy conclusions based on earlier successes (such as in India, Chile, or Brazil). A carefully designed development policy for this sector is highly recommended to suit the specific needs of particular countries. It would be highly advisable to seek advice and support from the international community in designing a policy framework aimed at stimulating and encouraging development of domestic IT industries and services.

As regards IPRs and IT services, evidence strongly suggests that the nature and extent of intellectual property rights issues changes over time as the industry matures. Moreover, low levels of software intellectual property rights protection can be harmful to developing country firms as well as companies from developed countries. The cost of intellectual property rights legislation enforcement however remains a major problem for developing countries. Several options for developing countries exists depending on their "user-driven" or "supplier creating" view of the industry.

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