Global IT Outsourcing

Software Development across Borders

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1 Introducing the phenomenon of global software work

1.1 Introduction

It is 9 a.m. Monday morning and Peter Kelly, Managing Director of Academy Information Systems in Trowbridge, UK, has just arrived at his desk. He sits down to examine the progress on the latest release of Academy software for housing benefits. For three years this development has been outsourced to Mastek, an Indian software company. Kelly consults the Mastek website relating to the project and the 'dashboard' shows relevant indicators of quality, utilization, efficiency and schedule. Subsequently, he meets Sanjay, Mastek's project manager, who updates him on the progress verbally. Part of Academy's project team has arrived for work six hours before Kelly and has already made progress on several programming specifications given to them the previous evening. This is because the majority of the project team live and work in a different time zone, country and culture at Mastek's India development centre in Mumbai. Around lunchtime in the UK, before the Mumbai part of the project team leaves for home, they transfer the completed code to the server in Academy's Trowbridge office. The UK-based Mastek and Academy staff then have time for testing the completed code before incorporation into the beta release of the application. They can then prepare detailed specifications for the India-based team that they will pick up electronically in the Mumbai morning.

This brief story is an insight into the day-to-day life of Global Software Work (GSW), which is the topic of this book. We define GSW as 'software work undertaken at geographically separated locations across national boundaries in a coordinated fashion involving real time or asynchronous interaction'. GSW can thus include work done across global borders through outsourcing, alliances, or subsidiary arrangements. GSW is still an unexplored form of work and is enabled through organizational forms quite distinctive from traditional global arrangements as typified by large multinational corporations. Unlike manufacturing activities and professional services such as consultancies that have been studied in the past, software development in global settings remains empirically largely unexamined. Software development is a knowledge-intensive activity, and typifies work in the 'knowledge' or 'network' society. An analysis of such work in practice can provide interesting insights into the kind and extent of operations that can be effectively conducted in conditions of globalization. GSW takes place within an extremely dynamic and diverse global marketplace that is populated by organizations big and small from countries both developed and developing. The GSW arena is thus unique in that firms need not be fatally handicapped by existing size, and can

potentially make an impact based on their knowledge competencies, ability to leverage technology and the cost advantages they offer. Diversity, complexity and uniqueness are thus inherent in GSW, making it an exciting and relatively unexplored domain of study. Analysis of GSW has implications for different disciplines concerned with such arrangements, including information systems, international management, computer supported collaborative work and organization theory. GSW arrangements are also of concern to policy makers responsible for economic growth and infrastructure development, particularly in developing countries such as India that has benefited greatly from an expanding export oriented software industry.

The aim of this book is to develop an empirically informed understanding of the process of Global Software Alliances (GSAs), the organizational arrangements that are established for the conduct of GSW. The evolution of GSAs are conceptualized within the context of globalization. We do this through the analysis of case studies that allow for an interrogation of various issues in the relationship from a variety of perspectives. Through inter-case comparisons, we seek to develop theoretical and managerial implications that can inform a better understanding about the conduct of the GSW phenomenon. The book can be read on two levels. First, and primarily, it can be treated as a study of globalization, examining specific cases that are both a model *of* and a model *for* globalization. Secondly, our analysis will be of interest to managers and practitioners charged with the task of undertaking GSW who are prepared to go beyond simplistic 'how to'-type guides and methodologies. The strength of the approach is in the use of case studies to provide an in-depth analysis of particular issues, together with rigorous employment of theory that can help to develop both practical and theoretical implications.

We have structured the book in eleven chapters that may be read in a linear fashion from 'cover to cover' or as a reference and resource in the GSW area. Chapter 1 introduces the phenomenon of GSW. Chapter 2 provides an exposition of the theoretical underpinnings of the research approach and chapters 3–9 describe and analyse key themes within the detailed case studies of companies involved in GSW in India. These cases are the result of research undertaken during the period 1995–2000, involving some 200 interviews. Chapters 10 and 11 are concerned with the implications of our analysis at a theoretical and practical level, respectively.

The aim of this chapter is to present the GSW phenomenon in depth and set up the theoretical basis for the subsequent analysis. This phenomenon is shaped by three defining themes relating to the nature of the organizational form that enables such work, the kind of work that is conducted and the complex global trends within which such work is carried out. A detailed discussion of these three themes now follows.

1.2 Organizational forms and GSW

Globalization is a key characteristic of change in many domains at the turn of the twenty-first century. The most visible aspects of globalization have been a bewildering collage

of transformations – increasing religious fundamentalism coexisting with greater secular human concern, development of centres of advanced technology amid regions of poverty and interconnectedness of systems and regions in ways that did not exist before. International business environments and organizational forms are being significantly reshaped as part of a new scenario that has variously been labelled as the 'new economy', the 'digital economy,' the 'network society', or the 'information age'. In these new environments, changes are especially visible in the kind of *organizational forms* being adopted to enable global work. A distinctive and defining aspect of these new forms is the manner in which *space and time* have become the primary medium through which to rethink the nature of the organization (Friedland and Boden 1997). An example of one such new organizational form is the 'Global Software Alliance' (GSA), a term we use to describe the nature of organizations established to enable GSW.

A GSA can be conceptualized as a relatively long-term inter-organizational relationship established between the outsourcing organization (the outcomes) and the outsourced organization (the contractor) based in different countries to enable software development in both real time and asynchronous time. This development occurs primarily in shared electronic domains with developers being located in the physical premises of their respective organizations (referred to as 'offshore'). The opening vegnette demonstrates a case of offshore programming and emphasizes the additional dimensions of managing projects across distance, time, language and culture. Offshore arrangements contrast with earlier 'body-shopping' (see below) where programmers from the outsourced firm carried out development while being physically located in the outsourcing organization (referred to as 'on-site'). Taking advantage of the increasing sophistication and capacity of telecommunication links and relatively lower labour costs in the outsourced organization, work in GSAs is done primarily in electronic spaces created through the use of information and communication technologies (ICTs) such as videoconference and email. While the physical travel of personnel between the vendor and contracting organizations can never be completely eliminated, the ongoing quest of both sides is to optimize costs by minimizing travel and finding the appropriate blend between on-site and offshore development. As GSAs seek to find synergies between remote and face-to-face work, time, space, organizational and national boundaries are recombined in novel ways where the experience of 'here' and 'now' loses its immediate spatio-temporal referents and becomes tied to and contingent on actors and actions at a distance.

Historically, the fortunes of firms in developing countries were seen as tied to the fortunes of those in the developed world. Our research into GSW provides some examples of firms in the developed world whose own fortunes are tied with equal potency to those in the developing world. Prior to GSW arrangements being possible, global work was primarily conducted by large organizations by virtue of their substantial direct investment transcending national borders. Based on their theory of a strategic mentality, Bartlett and Ghoshal (2000) categorized such firms as being *international*, *multinational*, *global* or *transnational*. At one end of the spectrum are international organizations that use their overseas operations in a marginal way, for example, simply to

supply raw materials and marketing contacts to the parent company. At the other end, transnational organizations seek to integrate overseas operations more fundamentally by developing global efficiencies while also creating locally responsive approaches. In between, there is the multinational corporation (MNC) which takes a flexible approach by modifying its practices and products across countries. Managers of transnational organizations adopt a global outlook and seek to develop standardized approaches based on the assumption that there are more similarities than differences across countries. In centralized global companies, foreign units are dependent on headquarters for funds and expertise, but the transnational selectively centralizes some resources at home and some abroad in keeping with the need to respond flexibly to different issues. The transnational corporation is characterized not by structure alone but by formal organization, information systems (IS), culture and values.

Although the Bartlett and Ghoshal typology may still hold in the categorization of different kinds of software firms doing work globally, what is interesting is that these firms are quite different from those that have traditionally operated internationally. Size and ability of the firm to make large-scale investments on infrastructure are no longer terminally limiting factors in whether or not they can undertake GSW. Rapid upgrades in information and communication technologies (ICTs) have reduced the cost of communication and increased the scope of operations so that relatively small companies can potentially have business relationships and can address markets in different geographical domains. Some firms, particularly in such sectors as software, web development and other new media supported by networked and shared IT infrastructures, are capable of competing with larger companies in the global marketplace. Being an Indian or Russian firm is less of a perceived disadvantage and such firms are infact sometimes actively sought by larger ones by virtue of the knowledge capital they hold, the cost advantages they offer and the potential they provide to serve as a basis to access new markets. Along with large IT companies such as IBM and Microsoft there are many examples of firms who despite being small, are 'born global' and are capable of operating in a multitude of domains and countries (Saxenian 2001).

Saxenian argues that today new transportation and communication technologies permit even the smallest firms to build partnerships with foreign producers and tap overseas expertise, cost savings and markets. Start-ups in Silicon Valley today are often global actors 'from the day they begin their operations' (2001: 5). This multiplicity of networks in which these firms operate makes it difficult to categorize them on single dimensions of domains of work or countries of operations. They are better understood on their ability to develop and sustain *networks* that enable the flows of information, expertise, knowledge, and capital. Networks allow these firms to switch rapidly between local and global domains and build competence in different functional areas and markets. For example, Arrk, a small UK-based software house located in the University of Manchester Science Park employing only forty people, has the majority of its programmers in India and an international portfolio of customers. Cisco Systems has defined its core competence as product innovation, marketing/customer service

and business relationship management. It delegates the rest, such as manufacturing assembly and product configuration, to its partners.

In operating these multiple networks, software firms deal not only with the strategic issues of whether or not and where they should globalize, but also with day-to-day operational issues including the creation of infrastructure, defining management processes and developing language and cultural understanding. Global projects have independent, autonomous links, and modules of work are distributed and coordinated using ICTs across wide physical and cultural distances. ICTs help both to intensify and redefine the nature of interactions across these different nodes which are not only confined to large organizations but also take place at the level of small firms and work teams. For reasons of geography and history, such as physical separation of different units and limited prior relationships of partners, these networks can comprise multiple short-lived global software teams (Carmel 1999). This is fundamentally different from firms composed of relatively autonomous units located in several countries as described by Bartlett and Ghoshal. However, the GSA relationship between the outsourcing and outsourced firms can take on different forms including joint ventures (JVs), vendor contract relationships and fully owned subsidiaries. New relationship models are also emerging: broker companies, for example, build databases of users and providers of outsourcing services and match firms based on predefined criteria. Some of these broker firms try to give more value than mere matching and provide project management services once the relationship is established. Another example is the 'hub' model where, for example, a Japanese firm may use its Singapore subsidiary through which to outsource to India. This model is used in an attempt to cost effectively and bridge some of the language, cultural and infrastructural gaps that would exist if work were carried out in India.

The organizational model adopted directly influences the pricing basis, that can vary from 'time and materials' to 'turnkey' or 'fixed price'. While in a time and material model development is priced on the programmers' time spent, in the other two cases, the basis is the estimated value of the whole project. The basis adopted has significant implications for intellectual property (IP) issues and the project control measures that need to be adopted. Where commitment in the relationship is not long term, and the aim is not to contract out new and core technologies, vendor contracts rather than JVs and subsidiary arrangements might be preferred. Relationships operate over different levels of a *trust continuum* (Heeks 1995) that is shaped by various considerations, including the length of the relationship, the kind of projects being done, the material investments made by both parties and the management capabilities to deal with the complexities of time, space and cultural distance. As the level of trust deepens, higher-end work can potentially be contracted out because of the increased level of confidence on both sides that work can be carried out effectively at a distance.

In summary, we have noted at least three distinctive aspects of GSAs:

- The manner in which different units of the network are *physically separated and electronically coordinated* across time, space and cultural boundaries.

- The ability to enter into GSAs is no longer restricted to large firms with the inherent capacity to make financial investments, but is also populated with small and innovative 'born global' firms driven by technology, ambition, intellectual capital and cost advantages.
- There is a central role for *ICTs*, for coordinating activities across different work units and for defining the content of work. Interdependent work requires the outsourcing and outsourced firms to be linked together by much higher bandwidth than that required for more stand-alone projects. While these ICTs help facilitate effective coordination and communication, they come with their own challenges related to access, compatibility, protocols and standards and issues of power and control.

We build on these themes in the next section.

1.3 Nature of GSW

Software development and maintenance activities are the characteristics of processes of the 'new economy' involving programmers, software designers and analysts (collectively referred to as 'knowledge workers') engaged in designing, developing, testing and implementing software (referred to as 'knowledge work'). However, the nature of this knowledge is multi-faceted and continuously negotiated and contested by the various actors involved in the software development process (see for example, the case analysis of Sierra in chapter 7). GSW also reflects characteristics of other forms of global work in general where the focus is on developing standardization, productivity and efficiency. Ritzer (1996) labels such work as 'McDonaldization'. Based on an analysis of fast food restaurants, notably McDonald's, Ritzer develops a critique of current-day work practices and society as excessively concerned with institutions to *rationalize and control behaviour*. Drawing on Max Weber's views of rationalization, Ritzer identifies four dimensions of modern institutions:

- Efficiency
- Calculability
- Predictability
- Control.

As the case analysis of Witech in chapter 4 demonstrates, a constant quest in GSAs is to standardize and make efficient various aspects of infrastructure and work practices including, for example, defining the template in which project-related communication takes place. This quest for standardization and efficiency can also be viewed in the historical context of the software engineering tradition, and the continued attempt to impart structure and predictability to software development processes.

GSW involves the application of various kinds of *knowledge systems*, including programming languages, software development methodologies, project management techniques and the application domain. Different programming languages are used in software development, from the older FORTRAN and COBOL to the current Java

and Visual Basic. Several hundred programming languages have been developed for use in both general-purpose and specialized domains. In the 1960s and 1970s, as technology of language compilers developed, large IT firms like IBM, Hewlett Packard and Univac formulated their own languages to support proprietary operating systems and system utilities. Users in other domains also developed their own languages – for example Nortel Networks, a large telecommunications firm, had software for their digital switches written in a proprietary language called Protel. A key technology for GSW came in the 1980s. Common standards increasingly emerged and C and then C++ (considered 'open' platforms) became widely used for system software development. Although the development of standards remains contested, developers preferred these open platforms as these did not restrict them to particular technologies, or to specific firms with their proprietary languages and products.

Although global work is not a new phenomenon, distributed software development work is relatively new and begs the empirical question: can approaches to global manufacturing (for example, car assembly plants) or global services (for example, consulting) be transferred seamlessly to software development work? As software work involves physically intangible artefacts whose value is derived from qualities such as efficiency of algorithms, 'look and feel' aspects of the user interface, richness of features and so on, this distinction from the production of material goods is useful. Software work has distinctive features, for example, in contrast to manufacturing where production and consumption take place in separate physical domains, services are generally distinguished by the *inseparability* of these functions. This is true of a range of different services from hotels and medical work to legal and accounting practices. However, these services are also starting to be outsourced offshore, as reflected in the growth of firms providing legal and medical transcription services and also those specializing in various transaction-processing functions like billing and ticketing.

Production and consumption are separable to a major degree in software work, where at each stage of the development, artefacts such as program code and documentation enable outputs to be specified and disembedded from the development domain to other use situations. However, information systems research has increasingly established that software design and development is never really 'finished', but involves an ongoing interaction and redefinition with the process of use (Bjerknes, Bratteteig and Espeseth 1991). Development and use of software can thus be quite distinct, linked together by various artefacts, and simultaneously be also intricately interconnected. Managing these *complex interdependencies* is a defining aspect of GSW.

Software may be regarded as a knowledge industry but is different from the traditionally accepted knowledge work of consulting in which many aspects rely fundamentally on the expertise of individuals, making it difficult to obtain economies of scale. Software work covers a range of activities including the development of algorithms and user interface designs that require creative talent of the highest order that cannot be scaled up in a mechanical fashion. Friedman (1989) points out that software work of this nature is continually being disciplined, formalized and made subject to managerial control, but

that this is thwarted by factors such as rapid changes in technology and the associated lack of skills in these new domains. Other activities in the spectrum of software work include the work of call centres, data entry and medical and legal transcription that typically need a minimum level of English, typing skills and ability to use a word-processing program. Such work can easily be scaled up with a suitable work place and telecommunications infrastructure, wherever people with these minimal background skills are available in large numbers. In between these extremes, there is a range of activities that demands different degrees of knowledge and skills, and is amenable to varying degrees of scaling up. For example, while maintaining legacy software does not need creative talent of the highest order, it needs individuals who can, in a short span of time, learn new languages, understand the complex relationships in a large piece of software and sensitively operate in the use domain. The extent of separability and scaling, therefore, varies for different software tasks and is significantly shaped by the infrastructure in place, including the available bandwidth, the degree of sophistication of management processes and the prior experience of the partners.

In GSW, tasks at various stages of the software life-cycle may be separated and implemented at different geographic locations coordinated through the use of ICTs. Maintenance and testing were among the first tasks to be outsourced, while early life-cycle tasks such as design and user requirements analysis were considered more difficult to contract out as they required more intimate knowledge of the firm's work practices as compared to maintenance and testing. On the face of it, those types of technology oriented development appear better suited for outsourcing where specifications can be developed and given to an outside party to execute. However, design tasks become harder to undertake because they assume a close familiarity with the market and user preferences. Alternatively, in modular approaches, modules of the software are divided into independent modules and its development 'outsourced' to teams in different locations.

Intangibility, heterogeneity, mobility and scalability are features that differentiate software work from other services and also manufacturing activity. The mental or intellectual activity involved in software work is captured in a form not tangible in the literal sense of being touchable by a human hand but nevertheless is made perceptible through magnetic or optical readers and other devices. The heterogeneity of software work is often limited by the standardization of development processes, methodologies and programming languages. While new and innovative work involves heterogeneity at early stages of conceptualization and design, it requires less at the stages of testing and implementation. Standardization of processes is central to disembedding and fragmenting of software processes to make them amenable to GSW. Perishability, especially important in services like hotels, is not so in software since artefacts like software code and manuals provide mobility with the use of ICTs and enable the life of the software to endure over time.

Another distinctive aspect of software work is the variety of social and human issues that come into play in the phases of design, development, implementation and interpretation of its longer-term implications. Software work, when carried out in a

global setting, magnifies these complexities as it involves relationships of people, teams, organizations and nations with different backgrounds, spoken languages and styles of working in conditions of temporal and spatial separation. Standardization, which is the key to coordinating distributed work, is extremely hard to implement because of the complexities of GSW. Whereas many firms in the manufacturing and services industry try to downplay national and cultural issues through standardization, managers of certain GSAs may capitalize on local ideosyncracies, strengths and creative energies (for example, the case of ComSoft described in chapter 5). While large MNCs are widely seen as weakening of local cultural values, smaller software firms (like ComSoft), in contrast, often attempt to reassert these identities in an effort distinctively to define themselves, drawing upon resources like national and cultural identities in the face of global competition. An ongoing challenge is how to find the appropriate blend between universal solutions and local particularities in a context inherently characterized by a multiplicity of networks.

Another key feature of GSW is the manner and speed in which its knowledge content is subject to change and radical readjustment and is characteristic of work in Castells' (1996) 'network society'. Founded fundamentally on technology and information, GSW involves a new form of 'informational capitalism' in which time, space and knowledge are key resources that entities try to dominate and standardize using various organizational forms. Changes, both technological and organizational, are the norm in GSW. The rapid uptake of Web-based systems by businesses has radically changed the skill sets (like Java) required for software development, for example. Changes are taking place at many levels, from the business models adopted to specific policies and procedures implemented to stem the attrition rate among developers. To deal with these rapid changes, firms need reflexively to monitor and modify their processes on an ongoing basis.

GSW, as we use the term, is broader than the traditional 'software outsourcing' that involved the purchase of goods or services previously obtained internally. Box 1.1 shows Apte's (1990) summary of the activities that were typically outsourced in the past. Prior to the early 1980s, the involvement of foreign companies in outsourced work of this nature was restricted mainly to data-processing or coding-type projects completed by a team of on-site foreign contract programmers. GSW now commonly involves the design and development of new products, support, special services, and whole-life-cycle projects involving different levels of complexity. While 'outsourcing' refers to work contracted out to third-party firms, typically located in the same country, GSW includes work done by subsidiaries and alliances that are necessarily located in a different country. GSW involves turning over to this third party or offshore subsidiary some or all the software development and maintenance tasks, ranging from simple data entry or programming to complete software design, development, data centre operations and full system integration. As the software component in hardware such as telephones, DVDs, cell phones and in cars and airplanes increases, the demand for outsourcing has multiplied (Box 1.1).

Box 1.1 Outsourced IT services

- Data-processing services: data entry, transaction processing, back-office clerical tasks
- Contract programming
- Facilities management: operation and support of data centres
- System integration
- Support operations: maintenance services and data recovery
- Special services: training, hotline support

Source: Apte (1990).

GSAs allow for a range of possibilities both in terms of the kind of projects contracted out and the extent to which the different stages of the development life-cycle can be outsourced. Issues that influence these decisions are the strategic importance of the activity, the degree to which the requirements can be specified and the comparative cost of having the software developed in-house versus having it outsourced. Various arguments have been made for and against companies contracting out core projects: 'never outsource a problem, only a defined task' (Willcocks, Fitzgerald and Lacity 1996; Willcocks and Sauer 2000). Gurbaxani (1996) argues, to the contrary, that innovative projects can be outsourced with support of a strong contracting structure, presence of multiple vendors and a selective outsourcing strategy. In addition to this debate on what should be outsourced, there are also discussions on whether firms should go for 'total' or 'selective' outsourcing, ranging from small stand-alone projects completed through short-term employment of programmers, to projects where the third-party vendor is completely in charge of hardware, software and staff. Total outsourcing can involve design, implementation and maintenance of large projects, or even the support for whole pieces of legacy software or the porting of them to alternative platforms.

While the issues referred to above have been debated extensively in the information systems literature, they remain open empirical questions in the GSW domain. McFarlan (1995) has argued that 'highly structured' projects where processing, file structures and outputs are completely defined, are easy to outsource, as compared to those whose outputs are more open to the users' changing judgement on desirable features, for example, in business process re-engineering projects. Such projects, it is argued, are best done in-house in conditions of co-location and proximity. In addition, to reduce ambiguities in design, Kobitzch, Rombach and Feldmann (2001) argue that structured projects are amenable to an 'engineering' approach which makes it easier to scale up and achieve economies of scale that justify the investments required for establishing a GSW infrastructure. This is related to the maturity and compatibility of the structured processes in both the outsourcing vendor and client organizations. Our empirical work in Japan (see chapter 9) suggests that firms there may be more willing to operate in relatively unstructured projects as compared to North American firms, and this can

potentially challenge the popular contention about the need for structure in remote work. While it is still early to say whether the Japanese approach will be successful, their experience will provide key learning for the practice of GSW.

In summary, we have pointed out four distinctive features of GSW:

- GSW does not reflect either a traditional manufacturing or service activity, and includes *elements of both.*
- GSW can take on varying levels of *sophistication and need for creative and intellectual inputs*, ranging from call centres to designing new technologies.
- The *scalability* of GSW varies with the nature of work and the life-cycle stage of the project.
- *Social and human issues* in GSWs are magnified as compared to traditional outsourcing because of the increased diversities of people, practices and technologies involved.

1.4 Global trends in GSW

What makes GSW particularly interesting is the diverse global network in which it takes place. This diversity is expected to increase in the future since different predictions on the size of the GSW market present a healthy picture of growth that no doubt will attract new producers. The demand for and supply of GSW has increased substantially since the early 1990s with continued demand from well-established users in the USA, UK, Australia and various Western European countries. Japan and Korea are fast emerging as customers and in some cases are also aspirant producers of various categories of GSW. According to the International Data Corporation (reported in Krill 2001), the USA is likely to continue to be the most significant user of GSW, with predicted increases in spending from $5.5 billion in 2000 to a rather optimistic $17.6 billion by 2005. At the time of writing, such predictions on the size and growth of GSW can be considered less than reliable because of the US recession and war in the Middle East. However, substantial growth of GSW throughout the 1990s was stimulated by such factors as demand for 'e-enablement' of enterprises and an international shortage in IT skills that forced firms to look offshore for resources. Other factors concern continued momentum towards IT outsourcing in countries such as Japan and Korea, in part due to the gradual erosion of the guaranteed lifelong employment structure. On the supply side, deregulation of markets in a number of developing countries, and a series of initiatives in countries such as China to address issues of English language and telecommunications infrastructure, have helped to position previously 'inactive' countries more prominently in the global marketplace.

Castells (1996) presents a view of the informational global economy as a network organised around *key metropolitan centres dispersed globally*. These centres comprise important 'nodes' for the structuring and management of intertwined activities at different levels, including firms, teams and individual actors. Castells' notion of a 'network'

refers to both the physical (transport, computer systems and telecommunications) as well as the social (educational, expatriate networks, trade associations, personal contacts, etc.), in which economic, social, religious and even criminal activities need to be considered. The financial capitals of London, Tokyo and New York are good examples of major 'command and control' centres supported by various secondary nodes for the execution of various functions. Similarly, GSAs can be conceptualized as networks of users and providers of GSW services, infrastructure suppliers and a host of other actors. In GSW, global nodes situated around cities providing international market access to skills and knowledge structures serve global networks of firms. Telecommunications systems allow dispersion of these nodes around the globe, yet the nodes are themselves characterized by dispersion and concentration. The actors in these networks are connected by flows of various types of information, knowledge and capital, which help to shape the networks and also open up the possibilities of establishing new nodes. For example, Indian firms, through the experience and knowledge gained with North American companies, are actively establishing new markets in Japan and Korea. An implication of this networked perspective on GSAs is that it is inadequate to consider relationships only in one-to-one configurations (for example, an Indian and a North American firm), but to situate the analysis within a wider web of users and providers operating in the global marketplace.

In the GSW marketplace today, joint dominance exists between the major 'technopoles' of Ireland, India and Israel that are being challenged by a number of other emergent centres such as Russia, the Philippines and China. Within these countries, the cities of Dublin, Bangalore, Moscow, Manila and Beijing comprise major GSW centres that in turn are connected in global markets and social networks, and also help to create various secondary nodes internally. Within each country, the networking architecture reproduces itself in dispersed regional and local centres such as Mumbai, Hyderabad and Delhi in India and Novosibirsk, Moscow and St Petersburg in Russia. These 'networks of networks' constitute a process by which the production and consumption of GSW are connected through information flows. Global (e.g. the USA and India) and internal ('in-country' or 'in-city') networks contain specialization and fierce internal and external competition between cities in different regions and states. Mumbai, Bangalore and Hyderabad firms, while competing with each other, also vie for global contracts, bidding against firms based in Dublin and Shanghai.

We now discuss some of the global nodes and emergent centres in the GSW network, with an emphasis on the specialization strengths and weaknesses, with a view to describing the complexity of this network. We start with the 'big three' nodes, India, Ireland and Israel before considering three major emergent GSW centres of the Philippines, Russia and China. (Owing to space constraints, we are not able to discuss other emergent centres such as Singapore, Malaysia, Pakistan and Sri Lanka in Asia; Brazil and Chile in South America; Hungary, Romania and Ukraine in Eastern Europe; and Egypt in the Middle East.) We also discuss the trend towards 'nearshore' software development that involves Canada, Mexico, the Caribbean and Venezuela.

India

Many estimates of software exports consider India to be the leader in GSW, registering an average annual growth of software exports of more than 40 per cent during the 1990s. The trade association NASSCOM (www.nasscom.org) estimate that India's IT software and services exports is worth $7.7 billion in software for foreign clients and there are plans to expand this to $50 billion by 2008. Software services currently account for 10.5 per cent of India's total exports, making GSW one of the key engines for growth of the economy. India has come a long way from the situation in 1985 when Texas Instruments first saw potential and, in a pioneering and landmark move, established their subsidiary in Bangalore. Texas Instruments realized the limited capacity of the Indian government to provide infrastructure and obtained permission to establish their own satellite links and related infrastructure. The remarkable success of this centre to undertake leading-edge work inspired other (mostly North American) firms to establish facilities in India, particularly in Bangalore. A number of these firms (for example, Motorola) aimed to do leading-edge work, and their Bangalore lab attained the highest possible quality rating for software processes of Capability Maturity Model (CMM) Level 5; in 1992, only one other centre in the world (IBM) achieved a similar rating. Motorola's success opened the floodgates for software work in India, and other firms followed, a few entering through the route of JVs, many through wholly owned subsidiaries and contract staff both on-site and offshore. About 265 of the *Fortune 500* companies are now customers of the Indian IT industry and leading companies (e.g. Microsoft, SAP, Adobe and Quark) are setting up development centres. The success of companies like Motorola and Texas Instruments challenges the popular criticism that India has been a centre for only 'lower-end' work. There are currently more than 3,000 Indian software services exporters doing business in more than 100 countries; 25 companies account for 60 per cent of the sector's revenues and it is this vanguard that is spurring the global expansion and development of the IT services' value chain.

A majority of the initial software work in India was of the type derogatively called 'body-shopping' whereby the developers would go on-site for the length of the project. This trend has been steadily changing and although in 1990, about 95 per cent of the work was done onsite and 5 per cent in India, in 1995 two-thirds of all software services export earnings were created by on-site work, and currently about 70 per cent of a given project's development is done in India. Although development in India as opposed to on-site means lower staff costs, it also presents tremendous challenges in managing attrition and coordinating distributed work.

While Indian companies have come a long way in building expertise in project management to deal with conditions of separation, they will in the future need to cope with further challenges arising from new competition (for example, China), and in developing new markets (in Europe and East Asia), building expertise in new technologies (for example, in mobile telephony), upgrading infrastructure and articulating new models for pricing and profit sharing as compared to the 'time and material' approaches of the

past. Reliance on the US market has made India's suppliers susceptible to reductions in IT spending and Indian companies have begun to explore opportunities in Europe.

Ireland

Ireland is often cited as the world's second largest software exporter after the USA with software exports ranging from an estimated US$4 billion in 1998 to US$8 billion in 2000 (Moore 2001). A large proportion of investment in Europe by US companies goes to Ireland, making them the second biggest exporter of software after the USA. They produce about 60 per cent of the packaged software sold in Europe. Ireland has the advantage of a strong technological infrastructure, EU membership, a sound technical education system, English-language competence, proximity and cultural similarity with the UK and the USA. Although arguably not as innovative or entrepreneurial as Israel, the Irish software industry turns out software products as well as a variety of support services. O'Riain (1997) traces the growth of the industry after 1973 when major MNCs were attracted by the Irish Industrial Development Authority's policies of financial incentives and significant investment in education and telecommunications. The late 1980s led to the arrival of sophisticated systems software companies such as Iona that were tempted by tax incentives and an attractive location to supply to the EU. The early 1990s saw European unification, that helped a booming Irish IT industry to grow at the rate of 20 per cent for most of the decade. Almost 80 per cent of the Irish software industry's output is exported.

By the end of 1998, an estimated 20,000 people were employed in the Irish ICT sector and total exports were valued at £4.2 billion. In 1999, there were some 570 indigenous software companies, 108 of which were foreign owned through arrangements such as subsidiaries. The major focus of the work was at the system level, including programming languages and tools for data management and data mining. Companies have been building on this core in order to create software applications specific to enterprises and industries. Most Irish companies are in software services and bespoke development with an emphasis on providing Internet and multimedia consulting. The main markets served are financial services, telecommunications, middleware, e-commerce and specific localization. O'Riain (1997) points out that unlike in India, Ireland's development has avoided relying on contract programming or 'body-shopping' and, instead, many large MNCs including Anderson Consulting, Intel, Digital, SAP, Sun Microsystems, Ericsson and Prudential Insurance have chosen to locate in Ireland.

The growth of the Irish software industry has been enabled by the ready availability of skilled staff, low corporate taxation, generous incentives, low operating costs and world-class infrastructure including telecommunications. The government has played a key role in providing financial support to companies to set up and expand overseas (Cochran 2001). The software sector has been made a strategic priority, and support has come in the form of legislation on security and copyright as well as funding for research and development (R&D). This has helped to give the industry a high-quality,

low-risk image, and most of the firms have ISO accreditation or CMM of Level 2 or higher. The industry has been given a tremendous boost by the return of large numbers of technically trained expatriate Irish from the USA with a desire to contribute to the development of the country. The software industry thus is in a position of strength drawing from the state support, the strong inward investments by MNCs and a robust people base.

O'Riain (1997) identifies three future challenges to the industry:

- The industry's continued reliance on MNCs makes them potentially vulnerable to the risk of the companies deciding to shift their operations to other more attractive nodes in the wider GSW network.
- Irish companies need effective strategies to sustain their presence in the global economy in the face of a 'brain drain' of their educated people, especially the younger ones, primarily to the USA.
- The weak venture capital base and funding for R&D as compared to Israel, serves to restrict entrepreneurial development and the creation of new technologies.

Israel

Israel has emerged as a major global player in software exports, being one of the few countries able to seize the opportunities that globalization provided in terms of technology and knowledge, organizational forms, capital markets and specialized skills. Growth in the ICT sector started as early as in 1948, and Motorola set up their first subsidiary outside of the USA in 1964 (Ariav and Goodman 1994). Contributing to this early growth was the key influence of military-trained computing graduates who after completing their service entered the flourishing civilian computing sector. This trend still continues.

The military-inspired growth of the 1980s was further strengthened in the 1990s with the growth of high-tech 'clusters' involving start-up and venture capital firms strongly linked with the high-tech clusters of the US Silicon Valley and elsewhere (Teubal 2001). A number of new high-tech start-up companies opened in the late 1990s – about 2,500 firms in 1998 and 1,000 in 1999. In 2001, there were over 4,000 start-up firms and 120 organizations listed on NASDAQ. Venture capital from private, public and foreign sources has been the key in providing the impetus to growth in software exports. Today Israel has the second largest number of technology firms listed on NASDAQ after the USA.

The combined factors of public policy initiatives such as high R&D spending, a highly educated population, English-language ability, tax incentives, marketing support for software exports and a large expatriate Jewish population has facilitated strong links to markets abroad, especially the USA. The availability of high-quality telecommunications services offered by several competing providers has created a cheap and reliable infrastructure to support software work. Israel has a large proportion of technically skilled people, and connections with bankers and investors in the West. The return

of foreign-educated Israelis has supported continuing technology transfer and created a demanding and high-quality consumer base that gives the industry its reputation for being of high 'battle tested' quality. The process of globalization has fostered in Israel a new kind of export goods – the sale of high-tech start-up companies to MNCs. Teubal (2001) calls this sale of technological assets rather than traditional merchandise and service exports one of Israel's most important export categories.

The centres of Tel-Aviv, Haifa and Jerusalem form the key software development areas, and between 1984 and 1992, the Israeli software industry tripled its sales and increased exports by 2,700 per cent. This trend has continued, reaching $1.3 billion in the first half of 2000, a 40 per cent jump from 1999 (IPR, 2000). There are about 300 software houses in Israel employing around 20,000 people. Nearly a third of Israel's software exports are sold to the USA, the remainder to Europe, an increase in part due to Israel's specialization in the Internet and communications sectors. Other areas of export include database management systems, application generators, computer centre operation, educational software and anti-virus protection. Israel also exhibits strength in niche areas of quality assurance of products and tools, security systems for the Internet and distance education. Major companies including Microsoft, IBM, Intel and National Semiconductor have Israeli subsidiaries (Ariav and Goodman 1994).

Israel shows the promise of becoming stronger and reaching an equal status with Ireland and India as a major provider of software. Israel's industry however differs fundamentally from India in that the key focus is on software products rather than on services. Compared to India, Israel has the advantage of being closer to the North American and European market. As a result of a service orientation, Indian firms have needed to familiarize themselves with customers while Israeli companies have chosen to compete internationally by developing technological assets that require less local interaction. Israel, like India, was affected by the 2001 slowdown of the US economy, and will need to redefine their future growth strategies. In addition, De Fontenay and Carmel (forthcoming) point out that the conflict with Palestine has affected growth of the industry, with foreign-customer concerns over safety and reliability in the event of increased violence. The current dependence on military-trained personnel to drive the civilian software industry may also pose a threat, since transfer of military-based technology may be less relevant in the future global scenario.

Russia

Although not one of the 'big three' software producers, Russia competes with India for offshore contracts from the USA and Europe. The McKinsey Global Institute estimates that Russia's offshore programming sector will grow at a rate of 50–60 per cent a year in the early twenty-first century. Many large firms including IBM, Nortel, Sun Microsystems, Boeing, Motorola, Intel, SAP and Microsoft have already started operations in Russia. A recent report (ACCR 2001) indicates that there are 5,000–8,000 programmers in Russia and annual revenue is between $60 and $100 million, reflecting a

40–60 per cent average annual growth rate. Of software exports, around 30 per cent are products and the remainder software services, typically offshore programming work (Heeks 1999; Lakaeva 2000).

Russia has a number of advantages including costs (salaries half of even Indian wages), a high-quality technical education and the third highest *per capita* number of scientists and engineers in the world. Many of these scientists had experience in nuclear, space, military and communications projects and moved into the software industry after the collapse of the Cold War. Mathematics and physics are strong areas in the skill base and Russian students are often winners in international programming contests. The cities of St Petersburg, Moscow, Vladivostok and Novosibirsk in Siberia are emerging as 'clusters' or 'silicon cities'. Proximity to markets in Western Europe and shared culture and history potentially reduce cross-cultural differences relative to India or China. Novosibirsk has special relevance for Germany owing to a large ethnic German population. This makes Russia an attractive potential partner for German companies as compared to Indian companies which have the handicap of the German language.

Many of the Russian offshore companies have 50–300 programmers and are partly or fully foreign owned. Smaller companies with 10–20 programmers rely more on links with friends and acquaintances to gain smaller contracts. Typical firms offer a list of services including Internet programming, Web design, Web server applications, database projects, system programming, real time and embedded systems, internationalization, translation and localization of software. The major end-users of these products and services include financial institutions, governments, educational institutions, industry and telecommunication Internet companies. Text recognition, anti-virus programs and the entertainment sector are other areas where export success has been achieved by Russian firms. High-level scientific work is also being done in Russia. Intel opened a subsidiary in Nizhy Novgorod in June 2000 to develop and support software for the next-generation Pentium processor.

While the future for Russia's software industry seems good, it needs to strengthen its institutional infrastructure by building something equivalent to India's NASSCOM. Russian companies also need to develop more sophistication in North American and European business practices and project management and to develop quality control processes that are in line with international standards. Growth has come despite the poor image of intellectual property protection (IPP) in Russian organizations. English is not as widely spoken as in Israel or India and the costs of bandwidth are higher than in other major offshore outsourcing countries. Other emerging vendor nations outside, but in the region of Russia, include Bulgaria, the Czech Republic, Hungary, Lithuania, Poland and Ukraine.

The Philippines

The Philippines is emerging as a key venue for offshore development, second to India in Asia, and is already a strong contender in a broad range of back-office services.

The Philippines' offshore software industry partly emerged as a result of the volcanic disaster of 1991 and the withdrawal of the US military in 1992, leaving behind a relatively reliable infrastructure that could still support a range of services. The Philippine government capitalized on this and developed trade around telecommunication and IT-enabled services as contrasted with India's development strategy in software services. Software exports for 2000 were estimated at US$200 million but it is not clear exactly what aspects this figure covers. There are some 30,000 Filipinos in the IT-related sector in several hundred firms, many of which are foreign owned (Hamlin 2001). The Philippines' telecommunication services include call centres and data processing as well as IT services such as applications development, Web design, animation, database design, networking and software. A survey in 2000 by META, a US research group, ranked the Philippines number one among forty-seven countries in the 'knowledge jobs' category. Software 'clusters' have been set up in Subic Bay and the Clark Special Economic Zone, with airports, telecommunications, housing complexes and tourist facilities. This has attracted back-office operations mainly from the USA – MNCs such as Barnes & Noble, Arthur Andersen and America Online.

The strengths of the Philippines include a good IT infrastructure especially in Manila and Clark IT parks, low labour costs (30–40 per cent less than in the USA) a highly literate (94 per cent) population, and a high level of English-language proficiency. A strong industry association in the IT and e-commerce Council helps to present a positive picture of the industry with comprehensive information stressing the quality of service and life in the Philippines. However, a record of political instability and a relatively poor general infrastructure still inhibit foreign investment. While the main telecommunications companies are expanding rapidly in the IT parks where the infrastructure is well developed, other parts of the country are still lacking in good-quality business accommodation, roads and support services. The geographical spread of the country, comprising 7,107 islands, makes it difficult to establish fixed telecommunication lines. Philippine law has also been slow to catch up with the new economy, a factor that may deter some MNCs from setting up operations because of IP fears.

China

China represents a major emerging supplier of software services especially after World Trade Organization (WTO) entry in November 2001. The Chinese software industry has grown at more than 20 per cent a year since the early 1990s, which is above the world average. The growth in 1999 was 30 per cent, to $2.16 billion, and future predictions are spectacular, on a par with India's success. China is perceived as a future threat to India in part owing to a relatively advanced user base of mobile phones and many more telephone connections and a vast pool of skilled human resources. The role of the Chinese

government has been especially significant in attracting Chinese students in the USA to return home and establish new high-tech ventures. Saxenian (2001) quotes a survey that shows that about 18.8 per cent (around 160,000) of the Chinese students who studied in the USA between 1978 and 1998 returned to China to participate in these new ventures. This trend is significant as it supports the development of transnational networks of Chinese entrepreneurs with Silicon Valley, permitting a flow of capital, technology, marketing know-how and R&D into the Chinese companies. Through various science park-based 'clusters', the transnational networks intersect with the local and national networks to further support the diffusion of innovation. The Chinese success in repatriation contrasts starkly with the Indian case, where the return of professionals is only a 'trickle' (Saxenian 2001).

The government plans to boost software exports from $130 million in 1999 to $1 billion in 2004 by offering tax breaks and access to cheap capital and by relaxing rules on sending employees abroad (Ju 2001). China has so far concentrated on the domestic market, in contrast to India. Responding to the Chinese competition, many Indian companies have started to open up development centres on the Chinese mainland to re-route low-end activities like coding and maintenance. Some Indian companies are even hiring Chinese programmers who are less expensive than Indians (by approximately 15 per cent) and their language background makes them more suitable to support the efforts of Indian firms to penetrate Japanese projects. The Chinese workers, however, have lesser experience in the areas of systems integration and project management.

The Chinese market is divided into system software (12 per cent), application software (63 per cent) and supporting software (25 per cent). China has about 400,000 people employed in the software industry spread over the economically developed regions and coastal areas such as Beijing, Shanghai, Shenzhen, Dalian, Shenyang, Fujian and Zhuhai. Beijing is set to become China's largest software production centre with the municipal government approving 221 new software companies in 2000. The Zhonguancun science and technology park in Beijing represents China's Silicon Valley and is home to IBM and Microsoft. There is also the potential for Hong Kong to serve as a hub for outsourcing to the Chinese mainland as it is considered less risky and there are more English-speaking people. Already, the Chinese cities of Guangzhou and Shenzhen are host to a growing number of satellite offices for Hong Kong software companies. Some current barriers to growth include factors similar to those in Russia: poor English-language capabilities outside of Hong Kong, weak understanding of Western business culture and a poor reputation for IPP. To a greater extent than in India, Chinese companies have a vast domestic market to concentrate on and the Chinese official machinery is making efforts to address these limitations, making China a potentially significant future player in the GSW marketplace.

Figure 1.1 provides a brief summary of the major facets of these major software exporting countries, showing the spatial organization of the major centres.