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National Information Infrastructure Policies in International Perspective

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NATIONAL INFORMATION INFRASTRUCTURE POLICIES IN INTERNATIONAL PERSPECTIVE

Introduction

There is a presumption, never proved, that investment in information technology increases productivity. That presumption is supposed to hold at the level of individual organisations as much as at a national level. It stands behind the idea of information infrastructure either as a positive incentive to economic growth, or as a source of national unease. The two underlying motives for the massive investments in national information infrastructures currently under way are (1) the fear that failure to do so will result in an inability to maintain communications, social, intellectual, and even business links with those countries which do invest, and (2) the belief that investments will not only be repaid by economic growth, but will boost economies measurably – the so-called "information pay-off".

The United States of America, which has invested most in information infrastructure but, as we shall see, has done so largely independently of national policy, is where one would expect the best evidence of informatics stimulated growth. Yet the debate continues about what the aggregate benefits of all that investment have been. Indeed, there has been a change in the way in which businesses and governments have communicated and calculated, but since the direct effect of an equitable information infrastructure has been to change business practices of most competitors, the relative advantages are illusive. Furthermore, the idea that the economy should be boosted as a whole is not supported by the long term trends in US economic growth. The period of high productivity growth was approximately from the late 1940s to the mid 1970s and this has been followed by a period of low growth. This ironically reverses the figures of business investment in computers, which began to grow exponentially from approximately the end of the period of high growth. It may be, as seems to be a doctrine of faith, that it will just take longer for the effects of informatics to make themselves apparent in the economy. Or one could argue, counterfactually, that if investments had not been made, then productivity growth would have been even more poor than it has been. Or it may be that we simply do not know how to use the enormous powers which information and communications technologies offer, and that as soon as such skills or appreciation or utility become widespread, then we will see the payoff.

It is evident that some sectors have benefited, and many people believe that their lives have been considerably improved, not least in the workplace. These sectors include the financial and other services industries which have continued to grow very rapidly (although not much more rapidly than their rates of growth, which predate information technology might have indicated). All economic sectors in the leading industrial coun-

tries have adopted computerisation to some degree, and the majority have grown (although this is only repeating the fact that total world productivity grows, as it has done since at least the Middle Ages). There has, of course, been a tremendous growth of the huge new industry which manufactures for and services informatics, and there is now a massive trade in what Professor Danny Quah of the London School of Economics calls the "weightless economy". However, it is not mainly for the sake of such producers of the information infrastructure that the great new initiatives have begun, at least that is not what the proponents of such new policies claim.

The eight brief studies presented here are an effort to describe the character and the context of a few illuminating efforts to address these motives. There is no way, short of a full encyclopaedia of material covering every nation in the world, to characterise the whole of the efforts now being undertaken to create appropriate infrastructure. This study has chosen only eight countries to examine, and the purpose of the examination is narrow and specific, but it addresses what we believe to be the key issues at the core of the debate about what information infrastructure is and which efforts are central to its development.

These issues are the policy and economic context in which infrastructure development occurs, the specific information and communications technology policies, and in some countries specific NII related projects which are being implemented, and the general social and economic impacts that are expected to emerge. In different countries different issues loom large, often matters which may seem at some distance away from the core issues of information infrastructure. Sometimes these are rooted in domestic political conditions, sometimes in matters of industrial structure, sometimes in the willingness or the capability of the government to support, regulate or otherwise co-ordinate infrastructure development.

The domestic political conditions within which national information infrastructure projects are being developed vary greatly around the world, and that variety is exemplified in the eight countries described here. Some countries, such as Singapore and the Republic of Korea have popular consensus and legal powers to channel private as well as government money to contribute to meeting developmental goals such as universal access. Other countries, such as India and the USA either do not have the legal powers or the resources to channel large amounts of money, and their mechanisms for infrastructure development work in more indirect ways.

Industrial structure differs in these countries in ways which greatly affect the expression of economic interests as related to information infrastructure. In countries where the power of the media industry is great there is correspondingly great emphasis on the content dimensions of information infrastructure. Where the relative power of the hardware production industry is great, as in Japan, we see a strong emphasis on projects which support their interests, including grand plans for new high technology cities or massive regional transformations.

The ability to use other kinds of tools to promote large scale transformations also varies, especially with regards to regulation. Where competition and regulatory reform play

central roles, as is the case in most countries engaged in serious efforts, different traditions of regulation exist, and there are differing levels of effectiveness as regards enforcement. Even within the European Union, which now operates under a principle of harmonised regulatory and competition law for the telecommunications industry, there are major differences between those countries with a tradition of an independent regulator and those who have practised some form of self-regulation. There are also major differences in the ability of regulatory authorities to sanction certain behaviour, to fine or suspend or otherwise punish companies which violate regulatory directives. Other countries, such as Turkey, simply do not have the political consensus or the administrative capabilities to promote large scale developmental projects.

In September 1993 the Information Infrastructure Task Force (IITF) of the United States government issued the "National Information Infrastructure: Agenda for Action". The purpose of this agenda was to provide a coordinated development of high capacity, interactive communication facilities which would include means for the internet, other telecommunications, and a variety of special media services to be made available on a large scale.

Although the US report came out over a year after the comparable policy initiative in Singapore, it was immediately following this report that every government which harboured hopes of enhancing their nations' involvement with new media technologies responded. This special issue of the **Emerging Technology Series** sets out a range of such responses among countries, which either represent leading efforts (Japan, Singapore, the USA), typify the response of a variety of nations (the Republic of Korea), or demonstrate the special problems of developing or otherwise problematic countries (India, Philippines, South Africa and Turkey). The choices also take into account the differences between those countries which are trying to define new directions for information infrastructure and its technology, those nations which are anxious to respond to the leaders, and those which are pressured to accommodate what they see as a forced pace of change. The nations studied also range in terms of political economy, such as those which have well established competitive market systems, including many private sector telecommunications companies. It also includes countries which are in the process of making major transitions to economic systems congenial to information infrastructure projects, such as loosing state control or other constraints like import substitution policies. Other countries are merely anxious not to be left entirely outside the networks which the new infrastructure projects are creating, but are struggling against either great poverty or strong vested interests and ideological limitations.

There are many distinguishing features unique to particular nations. Each has its own legislative context with not only differing laws but also differing approaches to enforcement. Different countries have distinct market features, differing not only in the spread of spending power, but also on the attitude towards communication and the use of information. These are to some degree the products of competition and other pressures, but to some degree the result of education or directly of cultural differences.

Despite these differences, we presume a common background of activities which set the framework for information infrastructures, in addition to the economic pressures from

the USA and other leading infrastructure developers. These include the transformation of the existing telecommunications companies from monopolies or near monopolies to more competitive, trade oriented businesses. It also refers to technological changes including the production of equipment which fosters feasible "convergence", including mass marketed internet, multimedia and advanced telecommunications hardware and software. We also recognise two other forms of "convergence". One form is the industrial alliances, mergers, acquisitions, and other arrangements which have brought together telecommunications companies with computer hardware and software producers, specialist consultants, and other related players. The other is the "convergence" of legislation, including trade treaties, which have changed the legal possibilities for international investments, for enforcing pricing policies, for defining the base upon which competition takes place.

Each case will be presented systematically so as to enhance the possibilities for comparison. We begin each description with a review of the national and regional context. Following this we review the existing infrastructure, paying special attention to the telecommunications systems, extent of computerisation and the penetration of the internet, and the relevant skills base. We also review the existing and planned policies which directly affect information infrastructure, especially those dealing with the telecommunications industry.

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United States of America

National and Regional Context

The entire issue of the United States NII is marked by the paradox of a political agenda which at once encompasses both a rhetoric of national leadership in the world of advanced information infrastructure and at the same time seems to place the entire initiative in the hands of the private sector. That appearance of an entire private sector led activity is a bit misleading, insofar as there are effective US policies and indirect investments made in infrastructural activities. However, the powers of the federal government, and to a lesser degree the state governments are much weaker than in most other countries. This is paradoxical because it was the US plan for NII which crystallized the whole debate and led to the explication of most other national policies.

One of the most striking features of the information infrastructure is that although in every sense it is worldwide in its reach and content, it is so markedly dominated by commercial activities in the USA that all aspects of communications everywhere are affected by what happens there. This is true because over half of the world's telecommunications passes through the USA, over half of the world's internet web sites are located in the USA (most of them are located in Southern California alone), and over half of the information and communications technology equipment and software are produced in the USA.

The real significance of US government policies in relation to information infrastructure is not that such policies dominate global, or even national, activities. Rather it is the case that even small effects upon US based companies or the behaviour or legal basis of activities in the USA inevitably have massive knock-on effects worldwide.

It is in the USA that the arguments for investment in information technology are most solidly based on the rhetoric of beneficial economic performance. There is also some influence from arguments about a perceived technology gap, especially with regard to Japan, but that is usually hidden and in any case it appears only in times of explicit political utility. Most of the practical initiatives have long taken place at the local level, as is the case with the "Smart Valley Infrastructure" project in San Francisco, which is supported by tens of millions of dollars from the local telecommunications and information technology companies.

The flagship national initiative was launched on 15 September 1993 with the publication of *The National Information Infrastructure: Agenda for Action*. This quickly became one of the defining features of the first Clinton/Gore administration and one of two projects that Vice President Gore has been most prominently associated with (the other being the environmental policy initiatives).

The content of the *Agenda* is far too broad and vague to define a coherent policy, ranging as it does from economic and social issues to ones concerning the delivery of public education and the technical features of infrastructural hardware. The management of the

initiative is in the form of an *ad hoc* task force which has representatives from executive branch agencies as well as a few private sector participants and academics. The leadership was largely located in the Department of Commerce. This form of administration has circumvented the necessity for Congressional approval, but it also placed the whole of the US NII on an essentially unlegislated basis.

When, in the late 1980s, commercial exploitation of computer networks became the common expectation among national network users, few in the communications industry, let alone within the Government, were convinced that they needed to act. Only a few years later, and especially with the boom in use of the World Wide Web, did the attitude change dramatically. The NII grew out of a number of trends, which are well exemplified by the Information Infrastructure and Technology Act of Congress of 1992 sponsored by Al Gore, when a Senator, and which extended a series of bills supposed to promote computing in various sectors, especially in schools, libraries, health care and manufacturing. The 1993 *Agenda* allowed these activities to form the basis of national policy and to set out a blueprint, which took into account the converging features of communications, computing, publishing and related activities.

Telecommunications

The telecommunications infrastructure has been private in the USA and there have been many efforts to ensure competition in the sector, at least among domestic corporations. Largely as a consequence of this competition, the prices for leased circuits are much cheaper than those in Western Europe and Japan (typically from one-fifty to one-third), nearly two-thirds of the world's leased circuits are located in the USA.

The burning issues in the USA is the debate about how free is the competition both among domestic providers of different kinds of telecommunications services, and between domestic and foreign competitors. The nature of the industry is such that there are always complex cross subsidies among services and between services and infrastructural hardware. Whether long distance telephoning should subsidise local telephoning, or whether rental charges on lines and equipment or value added services should be used to subsidise more intensive users of local calls, and other such questions come to the heart of the difficulty in defining precisely what constitutes competition in the industry. So far, we have seen inconsistent behaviour of courts and the unpredictable actions of the Justice Department when it comes to matters such as judgements about foreign company takeovers and anti-monopoly practices.

The regulatory environment in the USA is complicated not only by the split between federal and state levels of regulation, but also the variety of players at the federal level alone. The independent Federal Communications Commission, the policy oriented National Telecommunications and Information Administration of the Department of Commerce, the powers of the Justice Department in relation to competition policies and practices, the relations with the International Telecommunications Union maintained by the State Department, Congress and the federal district courts all have a say, and to some degree differing interests in the regulation of the telecommunications industry. The Telecommunications Act of 1996 resolved some of the tangle of regulation and reduced

barriers to competition between cable television operators, local telephone companies, long-distance carriers, wireless services, and other new competitors. These revisions were made after much debate, but with an awareness of the implications for convergence phenomena.

National IT Policies

United States national IT policies are not coordinated in a single, coherent form. Rather, they are separated into a variety of specific instances of policy, or they are general principles which appear as part of education policy or communications policies or policies which touch on business practices, such as antitrust matters. These are further separated between state and federal jurisdictions and even the seemingly straightforward matters, such as those concerning standardisation or broadcasting frequencies which are regulated by the Federal Communications Commission, are subject to scrutiny and sometimes court action at the state level.

The most important manifestations of these policies, aside from the regulatory standards which pertain to broadcasting and government procedural and communications protocols, is to be found in defence and research support. This is particularly so as it relates to large scale procurement, such as in military avionics, and "big science" projects such as in supercomputing activities.

The USA controls about 70 per cent of the total world market for software and its media industries, especially with regards to the recording, television and motion picture industry, are powerful domestically and internationally. The computer industry has become increasingly powerful politically and the efforts of the government to be seen to be fair in applying competition law and other relevant powers has recently been demonstrated in the continuous scrutiny of and occasional action against Microsoft.

Specific NII Policies

There is, ironically, no specifically defined NII goal for the USA. Furthermore, with the wide variety of interested groups it is unlikely that the core government policy for NII will be used to define specific goals. Issues such as privacy and security will be debated within the context of the initiative, and many coordinating activities, such as those associated with the "National Research Network" will be furthered. However, the much vaunted policy to "extend the 'universal service'concept to ensure that information resources are available to all at affordable prices" is not likely to have any concrete manifestation within government policy.

The initial goal of the NII was to build a seamless web of communication networks, computers, databases and consumer electronics throughout the USA. This was based on five principles:

1. Encourage private investment
2. Promote building through private sector competition
3. Make the regulatory framework as flexible as possible

4. Provide open access

5. Ensure universal service

The launch of the National Information Infrastructure project has had a massively disproprortionate impact on attitudes and expectations. One of its earliest tangible influences has been to boost the various projects to disseminate government information to the public and to manage more effetive government use of information technologies. Electronic mail has become a common means of communication and US government agency World Wide Web pages are among the best in the world.

Debates about encryption have animated much of the informatics community, and these have largely taken place within the context of NII activities. However, this is perhaps an excellent example of the limitations of government action, even where clear proposals about matters which seem to fall within federal jurisdiction are presented.

Conclusions

The NII of the USA is likely to be understood as something markedly different from that in any other nation. Foremost is the fact that the initiative is primarily manifest in the efforts of private corporations and consumer behaviour, rather than in investment or infrastructure construction projects undertaken by the US government. The vision which has been repeatedly articulated by Vice President Al Gore and those who support his activities, including the President, have encouraged and spurred on a large number of people. This real effect can be seen in the confidence with which those in the informatics industry go about their individual activities to expand markets and services, converge and promote themselves as the aggregate manifestation of the country's dominance of the world information infrastructure.

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Singapore

National and Regional Context

Singapore is a unique case because of its small size, strategic location, strong government and rapid economic growth. As a city state with approximately three million inhabitants on 640 sq. kms. it has used tightly coordinated policies to create and fully industrialize its economy over the past 33 years since Independence. Per capita GDP in 1994 was US$ 18,000 and literacy is close to 100 per cent. Singapore not only prides itself in leading the world in the widespread application of information technology, it also credits its enthusiastic use of IT with much of its success. What further distinguishes Singapore from other states is also the nature of its government and its willingness and capacity to be the most important driving force behind the country's NII initiatives.

The lack of natural resources compelled Singapore to establish a high quality communications infrastructure, to invest in developing a highly skilled workforce, and to promote the adoption and diffusion of information technology. This in turn enabled the country to rapidly transform itself into a highly competitive and efficient entrepot and a global hub for business. Singapore is one of the most liberalized trading countries, but its domestic economy is strongly directed by the State, and local businesses are highly regulated but encouraged to export competitively. The government seized the initiative from the outset and invested in transportation and distribution facilities based around the Port of Singapore. Communications and computer technologies were regarded as priorities in the 1970s, and the government increased capital outlays for telecommunications by 239 per cent during 1974-1980. By the mid-1980s, the government had computerized the majority of its public services, including the economically central Port of Singapore Authority, and the domestically critical housing authority. Nearly 200 applications were installed in the national civil service and by the early 1990s, the rest of the government services were networked. At present, the government is implementing 'IT2000 – a vision of an intelligent island', a national IT plan formulated in August 1991 as well as Singapore ONE, a country wide broadband network which will form the backbone of the 'intelligent island'.

Telecommunications and Networking

Telecommunications in Singapore was operated by private enterprises for more than half a century, until 1972. In that year, Singapore Telecom was created as a government statutory board to plan and provide telecommunications services for Singapore. At that time, the government had launched an intensive industrialization programme and the need for good telecommunications infrastructure to support economic growth was imperative. In line with the national economic policy, Singapore Telecom geared its corporate policies to support Singapore as a centre of trade, commerce and information. Today, Singapore has one of the most modern and efficient telecommunication networks in the world, and has been so recognised by the World Competitiveness Report in recent years. Singapore's current telecommunications infrastructure achieved complete digi-

talization by the end of 1994, and at present covers an extensive undersea cable network and optical fibre cables linking all telephone exchanges; the fibre-to-the-curb programme was expected to reach all highrise residential and commercial buildings by the end of 1997. Further technological and network advancements are expected to be undertaken as the Telecommunications Authority of Singapore (TAS) increasingly liberalizes the Singapore telecommunications sector over the next decade.

At present, Singapore Telecom, which was privatized in 1993, and Singtel Mobile dominate the market for fixed network services and for mobile services respectively. Singapore Telecom was listed on the Stock Exchange of Singapore in November 1993. As the holding company of over 15 subsidiaries, including postal services, it had been given the exclusive licence to provide mobile communications services until 31 March 1997 and basic telecommunications services until 31 March 2000. With a market capitalization of about US$ 28.85 billion at the end of 1994, Singapore Telecom has been ranked as the largest company in Asia outside Japan. Singapore has signed up to the World Trade Organization's international agreement on telecommunications liberalization, according to which the country will fully liberalize this sector for the year 2000. This includes access to the domestic market, full liberalization of foreign investment activities and liberalization of the global mobile satellite communications systems.

Singapore has seen rapid growth in networking ever since the government established the Singapore TradeNet in 1989, and electronic data interchange (EDI) system for the trading community. TradeNet links a number of organizations that are involved in export-import activities, and these include government departments, trade and customs authorities, the Port of Singapore, freight forwarders, financial institutions such as banks, and civil aviation authorities. TradeNet facilitates the electronic interchange of trade information and documents in order to expedite the approval of imports or exports, port operations, cargo clearances and statistics compilation. The implementation of TradeNet has led to the Port of Singapore becoming one of the most efficient container shipping terminals in the world.

The success of TradeNet has also led to the implementation of a number of other sectoral networks, such as MediNet – which connects government and private healthcare organizations, CORENET – a network for providing information to the construction industry, AutoNet – which links users, vendors and manufacturers of automation technology, BizNet – which makes it possible for firms to make electronic submissions to government bodies in order to comply with statutory requirements, and LawNet – a legal database. The implementation and the active use of these networks in their respective economic and social sectors has led to the World Competitiveness Report 1991 rating Singapore among the top few countries to have effectively exploited EDI technology.

Singapore has also seen the rapid diffusion of the internet, with the Telecommunications Authority of Singapore licensing three internet service providers (ISPs) SingNet, Pacific Internet and Cyberway to operate internet access services in the country. Initial efforts to boost the use of the internet have focused on the government sector, education, and the corporate sector. Several government departments provide information and services via the internet, and many more on-line multimedia services are being planned

by both industry and the government sectors.

National IT Policies

One of the most significant aspects of Singapore's IT policies since their inception in the early 1980s has been that state policies for this sector have consistently attempted to balance diffusion and production of IT through demand and supply side policy interventions. A comprehensive national IT plan was adopted in 1986 which brought about a rapid diffusion of IT in both public and private sectors. The plan included specific objectives for training the high technology workforce, creating an IT culture, enhancing the telecommunications infrastructure, generating and supporting IT-related research and development, and fostering a vibrant IT industry. The success of Singapore's integrated approach to IT is evident from the fact that the country has the highest apparent consumption of IT hardware relative to the gross domestic product of any economy in the world, and also has one of the highest intensities of IT use anywhere in the world. According to the IT2000 Report, the percentage of companies with more than 10 employees using computers increased from 13 per cent in 1982 to more than 75 per cent by 1992.

Gurbaxani *et al.* (1990) have identified two problems that often afflict the development of IT capabilities in any country: one, the stagnation of local IT use resulting from supply side focus on export of IT products that are more sophisticated than those demanded at home; and two, the stagnation of local IT production resulting from high levels of IT imports that are too sophisticated to be manufactured by local firms but for which demand exists at home. Through appropriate policy interventions that dealt with both demand and supply aspects, Singapore has steered clear of both these problems.

The more significant aspects of policy intervention in this country include systematic computerisation in the government sectors, framing of national IT plans that address unambiguous goals such as the development of an adequate number of IT skilled personnel based on projections into the future, developing local production capabilities for domestic use as well as for exports, stressing global competitiveness, and emphasising the goal of transforming Singapore into an information society. Other policy measures aimed at encouraging the use of IT include procurement of IT products and services by various government organisations, directives specifying particulars for procurement, the provision of IT use incentives, and a variety of training programmes and awareness campaigns in order to spread IT literacy. In terms of manpower development in the IT sector, total supply of professional IT manpower increased from around 850 in 1980 to over 14,000 by the end of 1991. Apart from this, a significant applied research capability has been set up within the public sector in various government funded institutes and universities.

On the production side, the Singapore government has instituted a range of fiscal incentives to ensure that firms invest in local production aimed at both the local and global markets as well as in research and development, and has also helped establish an internationally competitive IT infrastructure in the country. The direct export of computer systems and IT services to end-users increased more than six-fold between 1990 and

1994 to Singapore $ 2.2 billion. These figures do not include the export computer peripherals such as disk drives, which alone accounted for more than US$ 4 billion in 1991. The IT industry in Singapore is expected to reach a total revenue of around US$ 5 billion by the year 2000, and according to an IT industry survey, around 47 per cent of Singapore's IT firms were expected to be engaged in the provision of on-line information services by the end of 1996.

By addressing both the domestic and the global marketplace, Singapore's IT industry succeeded in creating economies of scale, thereby bringing down the cost of equipment and making the technology more easily accessible for users. Unlike in countries like India, the export orientation of IT production policy in Singapore forced firms to manufacture to international standards in quality and cost. By pushing through large scale projects for the informatisation of the country as well as through other demand side interventions, the government of Singapore has succeeded in balancing diffusion and production imperatives. Further, while the government has provided the engine of growth for the domestic industry, it has also ensured that production capabilities are aimed at much larger global markets. Thus the key responsibility for nurturing and developing both IT production and diffusion in Singapore was taken on by the government itself.

Specific NII Policies

The IT2000 plan: The success of Singapore's national IT plan implemented since 1986 led the government to undertake the next stage of economic development through the more ambitious and broad-ranging IT2000 master plan. The IT 2000 initiative was based on a study that covered eleven major sectors in the Singapore economy. The aim of "IT 2000" is to ensure that IT is applied pervasively so as to improve economic competitiveness and the quality of life, and to transform Singapore into an "intelligent island" by the year 2007. The five strategic thrusts of the plan as enunciated in the IT2000 Report published by the National Computer Board (NCB) are as follows:

1. *Developing a global hub*: to turn Singapore into a highly efficient switching centre for goods, services, capital, information and people; to further develop Singapore as a hub for business, services and transportation; to enable companies to provide knowledge and information-intensive services from Singapore to points around the globe.

2. *Improving the quality of life*: to make work more efficient and chores less time-consuming so as to increase the discretionary time available to people.

3. *Boosting the economic engine*: to boost economic competitiveness through the innovative exploitation of IT in all sectors of the economy.

4. *Linking communities locally and globally*: to help strengthen social bonds among Singaporeans by linking like-minded people, or those with a common cause or interest, electronically; to cross geographical and cultural barriers and enable those outside Singapore to access

the nationwide information infrastructure; and

5. *Enhancing the potential of individuals*: to enhance the potential of all Singaporeans by making it possible to continuously re-train and re-skill them to keep pace with changes in working practices and technologies; to enable interactive distance learning using multimedia technologies and video conferencing to complement more traditional teaching methods.

The essence of IT2000 is the synergistic development of a well integrated but flexible national information infrastructure based on advanced information technology. The plan particularly emphasises the need to establish the right balance between integration and flexibility as too much integration could lead to over-centralisation and control, and too much flexibility could result in poor connectivity and loss of synergy. Singapore's NII framework consists of telecommunications networks which include cable, wireless and broadcast networks; common network services which include value added services implemented through software; national IT applications which can be implemented using existing telecommunication networks or which may require higher bandwidth and wireless features of future networks; technical standards to be based on international and de facto standards; and a policy and legal framework to address non-technological issues of a social, economic and regulatory nature. The National IT Committee (NITC) and the National Information Infrastructure Division of the National Computer Board (NCB) have been established to oversee the NII initiatives and the highly co-ordinated multi-agency efforts needed for their implementation. Apart from these organisations, Singapore Telecom and the Singapore Broadcasting Corporation also play important roles in the NII initiatives, mainly through establishing and continually upgrading their respective infrastructures. However, as the IT2000 Report states, "the vision of a world-leading new age for Singapore cannot be realised by the government alone. The government can show the way. But the intelligent island can only come about if the private sector and the public embrace the advantages offered".

Singapore ONE – "One Network for Everyone" – is a national multimedia broadband network infrastructure that will deliver a very broad range of services, to the workplace, to the home and to schools. This initiative is being spearheaded by three government agencies – the NCB, National Science and Technology Board (NSTB), and the Telecommunications Authority of Singapore (TAS). The government has assumed control of the project on the premise that left to the market forces, such a national information infrastructure may not be developed fast enough to ensure Singapore's long term competitiveness and its leading position as an advanced value-added information communications hub. The strategy that is being followed is for the government to initiate the project while the industry would be encouraged to co-operate and invest in the construction of such an infrastructure and to develop applications and services that can be delivered through it. TAS will be responsible for infrastructure development, while the NCB will guide the applications development. The NSTB will fund companies and research institutes in order to develop new multimedia technologies as well as new products and services to be delivered over Singapore ONE. The project is being implemented in two phases, the first to be completed by the year 2001 which will see the deployment of a pi-

lot core broadband network that will cover not only homes, businesses, and schools, but also provide virtual government services. By the end of the second phase in the year 2004, the private sector is expected to become the main driving force behind the project.

Singapore ONE comprises two distinct but interrelated levels – an infrastructure level of networks, switches and terminal equipment, and a level of applications and multimedia services. The infrastructure level will consist of a core broadband network as the backbone connecting several local access networks which will reach homes and businesses. The core or backbone of Singapore ONE will be built, owned, and operated by an industry consortium that will charge tariffs for its usage. This core network will have open access interfaces for connection to the various service providers and the local access networks. The local access networks may be based on various technologies such as the hybrid fibre coaxial cable and the asymmetric digital subscriber line (ADSL). At present, local access networks that belong to Singapore Telecom and Singapore Cable Vision can be used to deliver multimedia services.

By December 1997, over 100 applications were expected to be available over Singapore ONE. Singapore ONE is not merely aimed at providing economic benefits and competitive advantages to businesses that use the network, but it is also aimed at facilitating the proliferation of information and knowledge-intensive businesses that will expedite the rapid informatisation of Singaporean society.

Conclusion

Singapore was the first country in the world to take proactive policy measures and infrastructural developments. The country is well placed both geographically and in terms of its preparedness to make competitive gains and to benefit from these investments. What distinguishes Singapore from its competitors and other industrialised and developing economies is the extent to which the government has been able to anticipate future technological developments and opportunities and the extent to which it has been prepared to intervene in financing and controlling the rapid development of a national information infrastructure.

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Japan

National and Regional Context

Japan succeeded in the 1980s to build the world's most far reaching information infrastructure, especially well suited for maintaining industrial leadership. Since the early 1990s the economy in general has stagnated and the ability to continuously improve has been threatened. The strongest incentive currently is to ensure that sufficient investment and planning activities suitable for the structures of late industrialisation are maintained.

Japan has a population of almost 120 million most of whom are culturally and politically closely united. It has great wealth nationally,, with the majority of assets held in the huge middle class. The population is almost entirely literate and by virtue of the penetration of electronic consumer goods, there is a vast market for informatics goods and services.

Despite this high level of investment and economic development in the area, Japan still lags behind the USA in the diffusion of computers, with 14.7 personal computers used in business per 100 workers as opposed to 55.1 in the USA (West, *et al.*, 1997, p. 97). The ratio of connections to local area networks and cellular telephones is similarly poor.

This vast market is predominantly liberalised but there are many areas in which market mechanisms fail. Some of this failure is due to the persistence of somewhat artificial restrictions, such as those which preserve idiosyncratic technical standards, other practices are regarded as non-liberal because of the propensity of Japanese consumers, especially corporate customers, to source their materials from suppliers with long established links.

These features of the domestic market do not, however, affect export sectors and Japan has until recently maintained very large export surpluses. In the informatics industry the export of goods and services is also positive, with not only electronic machinery sold worldwide, but also telecommunications infrastructure and services well established within the region. It was to maintain this established position in export that prompted Japan to go along with the liberalisation initiatives of the World Trade Organization agreement on telecommunications.

Telecommunications

Nippon Telephone and Telecommunications (NTT) is the largest telecommunications company in the world by most measures and in 1994 had revenues of over US$ 73 billion. It formerly held the national monopoly and is still the major provider of telephone services in Japan. The Japanese Ministry of Finance holds over 65 per cent of the shares of the corporation, but it is currently trying to divest itself of a bit more. NTT is the leader of Japanese NII projects, but it is barred by Japanese law from entering foreign markets without foreign associates.

The current infrastructure has reached the point where narrow-band integrated service digital network (N-ISDN) is available in most of the country. The capacity falls short of

being able to transmit the full range of NII functions, but full optical network broadband ISDN is expected to extend nationally by 2015. Some of this network is already in service, mainly for commercial customers, through the NTT run information network system net (INS-Net) service. These initiatives are explicitly policy-led, under the general principle that the simultaneously developed infrastructure and applications should be based on role sharing between government and the private sector.

IT Policy

No discussion of the Japanese situation would be complete without mention of the role of the Ministry of International Trade and Industry (MITI). This is a much misunderstood agency of government whose role is largely that of a guide to government policy and an advisor to major corporations. They have a relatively small budget, much of which is devoted to research rather than to supporting industrial developments in the target areas. MITI has led in policy development towards the establishment of 19 "technopolis zones" which would contain the infrastructure for high technology industries and would encourage the application of advanced informatics. However, MITI's role now is different from the period before capital liberalisation in the late 1960's and 1970's. At that time the Ministry intervened in a wide range of activities, especially where joint ventures were agreed and patent rights were bought. Currently, the closest MITI has moved towards directing policy is to encourage multimedia software developments in five areas of government: education, research, medical/welfare services, administrative services and electronic libraries.

The Ministry of Post and Telecommunications has its own focus of activities. These centre on the project to connect 75 million households and public facilities by fibre optic cable by the year 2010. Using broadband technologies, the project will stress interactivity.

NII Policies

Japan responded quickly to the USA's agenda for NII by launching a series of national advanced infrastructure projects of their own, led by Nippon Telephone and Telegraph Corporation (NTT), the Ministry of International Trade and Industry (MITI), and the Ministry of Post and Telecommunications (MTP). It is generally assumed that the American initiatives sparked the establishment of Japanese infrastructure projects, but, just as was the case in the USA, several institutions, including NTT, had already laid much of the groundwork from the late 1980s, and this was implicitly used as a spur to American developments.

In 1994 NTT presented its "Basic Concept and Current Activities for the Coming Multimedia Age", and MITI announced its "Program for Advanced Information Infrastructure". Shortly thereafter, the MPT published a research paper, "Reforms toward the intellectual creative society of the 21st Century" which placed Japan's position relative to the USA in NII development.

The financing of the Japanese NII is as yet unclear. Partial estimates of costs are available, for example the associated investment needed to lay fibre optic cables is likely to be in the range from 33 to 55 trillion yen, with an additional 42 trillion yen necessary for building, wiring and switching equipment. Other estimates run to twice these figures. The Japanese Telecommunications Council is pushing for increased private investment, stimulated by tax incentives and interest free loans. In January 1995 the Ministry of Post and Telecommunications announced that 30 billion yen would be available on loan from the Japanese Development Bank to pursue NII projects through NTT and other private sector companies. Where the rest of the investment will come from is uncertain. Uncertainty is further created by the apparent conflict of priorities between MITI and MPT, each of which have been allocated US$ 1 billion for NII project investments. All such investments will have to take place during a period of almost unprecedented slow growth in the Japanese economy.

Two Japanese open computer networks are models of new applications: the AUCNET (which provides the electronic auction of used cars on a satellite-based multimedia system) and MISUMI (a wholesaler of die and mould parts that actively promotes EDI). One of the key impacts is the breach of traditional "keiretsu" relations of "closed network of firms" as computer networks enable the creation of global relationships and the rising cost of domestic procurement prompts Japanese firms to review their traditional policy of maintaining exclusive networks of local vendors and distributors. MISUMI provides opportunities for small firms to sell to a large number of buyers worldwide rather than exclusively to locally based factories.

AUCNET has nationalised the distribution of used cars, which traditionally was localised. This expansion require strong intervention by the AUCNET to inspect and guarantee the quality of the cars. Also, a seller of a car only needs to trust the financial solvency of the AUCNET without knowing the buyer.

Developing an interactive/broadband information communications network is a project requiring much time and money. Investment estimations for broadband ISDN have been done by NTT and others and they range from 33 to 90 trillion yen construction cost. There is a new urgency in many of these long term plans, most of which predate the 1993 initiative in the USA. Nevertheless, the rhetoric of competing with the USA is pervasive and extremely popular. That rhetoric did shift subtly in the years after 1993 to stress more interconnectability and convergence than functionality.

The Telecommunication Council's proposal of 1993 was to set the target for completed infrastructure construction at 2010 when Japan will have a peak total population. The estimated investment cost is 33 to 53 trillion yen, with an expected 123 trillion yen for telecommunication's related markets. In 1994, the internet and mobile communication demands began to increase dramatically, shifting some of the emphases in the plans. The Ministry of Posts and Telecommunications (MPT) disclosed its 10 trillion yen project. In May 1995, the Telecommunication Technical Council estimated the mobile communication demand and forecast 32 million cellular and 38 million Personal Handy Phone (PHP) subscribers.

Mobile communication is growing rapidly and the rise in demand for mobile telephones is expected to continue over the next ten years. Similarly, growth is expected to be based on the demand for internet services. The expected level of users in Japan is 22 million in 2000, with major investments expected from both the large telecommunications companies and from smaller internet services providers.

The information-communication infrastructure, as envisaged by the Japanese policy from the Ministry of Post and Telecommunications, has a four level structure. The first level comprises physical transmission media. This level is subject to certain social requirements such as stable supply, fair use, and affordable tariffs. Levels two and three are areas where the multimedia and new businesses will be generated. They require facilities which are versatile, innovative and convenient. Level four refers to the applications to society, including personal values and an adequate legal framework, as well as an efficient and effective socio-economic system that influences human activities.

Applications are intended to penetrate deeply into the normal activities of people, including facilities for the aged and facilities intended to help rectify over-concentration in urban areas. The latter includes access to jobs and services which tend to concentrate in large metropolitan areas. The intention is to help distribute people outside existing urban concentrations.

The Japanese hope to enable information technology to lead the transition to an economy led by internal demand. The assumption is that a high-performance info-communications infrastructure would help shift Japan's economy from dependence on exports to an internal demand-driven economy, rectifying Japan's trade surplus. This is supposed to bring with it new markets, the expansion of existing markets, and a significant boost in new jobs for the sector, amounting to almost 2.4 million jobs.

The main policy issues which are currently under active consideration include:(1) establishing subscriber network infrastructure; (2) developing and introducing new applications in public fields; (3) regulatory reforms to accommodate the convergence of telecommunications and broadcasting; (4) a new universal and tariff system; and (5) preparing the environment for the intellectually creative society.

This is to distribute broadband optical fibre to around 20 per cent of the population, and to ensure that it is in fit condition to use. Supporting application development and introduction is expected to emphasise improving the network at public institutions, such as schools and hospitals, which will play leading roles in network expansion through utilisation, operation and maintenance.

Competition was first introduced, in a limited way, in the 1985 telecommunications system reforms, following which a communications satellite broadcasting system was also established, and the media anti-monopoly principle was deregulated, while CATV systems were permitted to operate in wider areas. Further promotion of the private sector preceded the current World Trade Organization regime and in response to industrial convergence.

Conclusions

The status of the Japanese information infrastructure initiative is paradoxical in a number of ways. Although Japanese companies lead in the production of many informatics goods, the domestic market is not well served and the existing infrastructure, except in the case of new technology zones and 'technopolis' projects. As long as the implementation of policies continue to favour producers over consumers, neither directed infrastructure development nor organic growth of an information society is likely in Japan.

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Republic of Korea

National and Regional Context

In less than two decades, the Republic of Korea transformed itself into the eleventh largest industrial nation with an annual per capita income of more than US$ 10,000, earning it the title of a "tiger" economy. The Republic of Korea sustained its remarkable economic growth of around 8 per cent throughout the 1980s and 1990s until the East Asian economic crisis of late 1997. Although the Republic of Korea started in the 1960s with highly interventionist policies that targeted specific sectors of the economy, government efforts in the late 1980s and the 1990s have often aimed at liberalization and the promotion of technology-intensive industries. A decline in the production and export of Korean IT products in the early 1990s led to some concerns for the country's continued economic growth and competitiveness. In responding to this situation, both the Korean government and industry have clearly endorsed the new developments in the national information infrastructure and its key technologies as the key to a new competitive advantage for Korea within the developing global information economy of the future.

Telecommunications

The Republic of Korea launched a major programme of expansion in telecommunication services in the early 1980s through the Korea Telecommunications Authority (KTA). This led to a rapid growth in the telephone network and by the end of the decade the number of telephone lines had quadrupled. By 1993 Korea had more than 38 telephone lines per 100 people, a remarkable performance for a newly industrialized country. In the early 1980s, the government separated telecommunications policy formulation from the provision of services. Since then, policy formulation has been the responsibility of the Ministry of Communications and the KTA was established as an autonomous body responsible for a number of public telecommunications carriers. That body included firms that provided basic services, mobile services, paging facilities, marine communications, data communications, and travel information services.

Korea Telecom, the public carrier under the aegis of the Ministry of Communications, and Dacom, which was initially established as a monopoly to provide data communication services, are the two network providers in the Korean market, providing both domestic and international services. Cellular services are provided by two carriers, Korea Mobile Telecommunications and Shinsegi Telecom, while paging services are available from many private companies. Value added services such as electronic mail, electronic data interchange (EDI), and computer reservation systems have also seen rapid growth since the deregulation of the telecommunications sector. Korea Telecom is expected to provide broadband ISDN services by the year 2000. The Republic of Korea's government has also announced plans to construct a nationwide, high speed fibre optic network. In terms of the growth of the internet in the country, there were nearly 33,000 internet hosts in the country by October 1995, a major jump from a mere 13,000 in 1994.

National IT Policies

The Republic of Korea's emphasis on IT began only in the late 1970s with the country's fourth five-year economic plan, as policy attention until then was mainly on the electronics sector. The most important public research and technology-related institutions that have played significant roles in new technology development, the provision of technology-related information, training, and co-ordinated efforts amongst the state and private sector firms are the Korea Institute of Electronics (KIET), Korea Advanced Institute of Science and Technology (KAIST), and Korea Electronics and Telecommunications Research Institute (ETRI). Apart from these organisations, the National Computerisation Agency (NCA) was established in 1987 as the principal organisation for the development of information technology and national informatization.

The Republic of Korea's policies for the IT industry had all the elements of the regime adopted by India such as restricted foreign investment, high import tariffs for computers, government procurement of locally manufactured IT products, and government sponsored research. However, while India's production oriented policies relied on import substitution, including cumbersome procedures for technology imports, and high levels of protection for too long, the Republic of Korea's policies for IT production were a pragmatic mix of protection and policies that encouraged competition among local conglomerates, the *chaebol*. The sheer size of the *chaebol* and the range of electronic products that they manufactured helped create economies of scale, competitively priced products and more importantly, a range of technological capabilities, which enabled them to enter the expanding global market for IT products by the 1980s.

By explicitly targeting selected *chaebol* such as Samsung, Daewoo, Goldstar and Hyundai, by permitting rather than restricting international technological alliances and diversification into all areas of electronics, the Republic of Korea succeeded in creating and sustaining a large enough manufacturing capability for electronic products, including computers, and thus helped avoid fragmentation of production capacities. Further, large scale investments in the manufacture of semiconductors by Korean firms enabled them to indigenise to a much greater extent compared to Indian IT firms that were largely import dependent for crucial components. The Republic of Korea is today not only the world's fourth largest producer of electronics but is also the third largest producer of dynamic random access memories (DRAMs), an advanced semiconductor product; it is one of the largest exporters of computers in the world. Finally, the country's superior performance also had much to do with the close collaboration between state and industrial interests in the country, a strategy consciously modelled on the Japanese experience.

Although the *chaebol* are well known for their export oriented business strategies, the Republic of Korea's local market itself constituted an important source of demand. Both demand and supply side policies have been used by the government to promote IT production and diffusion. According to a recent World Bank study, the Republic of Korea's efforts to respond to the "information technology revolution" and the concept of "information society" have led it to emphasize the diffusion of IT since the mid-1980s; how-

ever, all such government efforts at diffusing IT have been linked to the promotion of the local IT industry. The Korean government provided the initial demand for locally manufactured IT products through its procurement policies, especially for the educational and administrative sectors, and by encouraging IT applications particularly in the area of industrial automation and process control. Although the public sector has been the major IT user in the Republic of Korea, the private sector, especially the manufacturing sector, has increasingly been adopting IT for industrial automation. By the early 1990s, more than half of all manufacturing firms in the country had deployed computer-aided design and manufacturing technologies. The policy emphasis on developing a large and competitive domestic market was in good measure responsible for a local market for computers worth US$ 600 million by the end of 1986, almost as large as the country's computer export market. Indeed by the late 1980s, while both computer and semiconductor export growth showed signs of slowing down, the domestic market was growing more rapidly than ever, and the Republic of Korea was seriously reconsidering its export oriented strategy in the IT sector.

Specific NII Initiatives

The Korean government launched an integrated computer-based information systems project in 1983 to drive the diffusion of IT into the private sector, foster the further development of the IT industry in the country, and to improve public services and access to public information. This project, which became known as the National Basic Information System (NBIS), when complete would include five basic networks: an administrative system linking central and local government offices called the National Administrations Information System; a financial information system linking around 140 banks, insurance companies, and other financial institutions called the Financial Information System; an education and research information system connecting more than 20 universities and research institutes called the Education and Research Information System; a national defence and security information system; and a public health and social welfare information system connecting health and social welfare organisations in the country. The first phase of the project has already been established with the implementation of the National Administrations Information System which by 1993 had created demand for IT products worth more than US$ 300 million. Despite some success in achieving its objectives, the project suffered from several weaknesses including insufficient funding, a lack of strong industry capability, decreasing government support and failure to generate the expected demand from the industry.

Some rethinking led to a new policy document titled "National Information Superhighway" which by 1995 was transformed into a blueprint for the Republic of Korea's national information infrastructure and was renamed the Korean Information Infrastructure (KII) by the Ministry of Information and Communication. According to the blueprint, the KII is designed as a national strategy to establish an efficient and advanced information infrastructure by maximising the cumulative effect between demand and supply, i.e. by stimulating informatisation on the one hand and by fostering the information and telecommunications industry on the other. The KII is expected to be implemented in three major fields:

1. The KII aims to construct high speed government and public information networks, called the New Korea Net-Government (NKN-G) and the New Korea Net-Public (NKN-P) respectively. The NKN-G is expected to connect central and local government agencies and various public organisations, including schools and libraries, by the year 2015 using fibre optics. Standards and interoperability would be ensured by the NBIS project which was initiated earlier to build an integrated computer network. The NKN-P will provide interactive broadband multimedia services to users in the private sector through fibre optic networks.

2. The project will also involve the development and implementation of advanced applications and services as well as key technologies in collaboration with industry, academia and research institutes;

3. The KII will lead to the enhancement of public awareness, the establishment of informatisation pilot projects, and the restructuring of environmental frameworks such as the reformation of current laws, policies and regulations.

The Ministry of Information and Communication has also announced the Basic Plan for Informatisation Promotion, a project mooted by the Korean legislature, judiciary, administrative and regional self-governing bodies to promote the informatisation of the country. This plan will also involve the development of a national backbone computer network which is expected to be implemented during 1997-2000.

Conclusions

A recent World Bank study has pointed out the most significant feature of the Republic of Korea's policy initiatives for the information and communications sector, i.e. the willingness and the ability of the government to continuously monitor and evaluate its policies and programmes in relation to emerging local capabilities, domestic market potential and external circumstances, and to undertake appropriate changes when required. Public-private partnerships, infant industry protection but with explicit deadlines for market opening, linking government assistance to performance standards of particular firms, and balancing domestic and export market concerns were only some of the more important aspects of the Republic of Korea's policies for this sector.

The development of the ambitious KII will require even more guidance from the Korean government in terms of coordination between a variety of public and private sector agencies and industries.

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The Philippines

National and Regional Context

Although the Philippines, a nation of 60 million, has not seen the kind of growth rates that characterised many of its East Asian neighbours, it is increasingly being seen as having the potential to become a major newly industrialising country within the Association of South East Asian Nations (ASEAN). The government of the Philippines has been implementing a national economic development plan titled, the Science and Technology Agenda for National Development (STAND), and popularly called "Philippines 2000". The STAND emphasizes the development and utilisation of new information and communications technologies to improve the Philippines' competitive advantage, to help the country reduce the incidence of poverty to at least 30 per cent and below, to increase annual per capita GNP to at least US$ 1,000, and the level of exports to around US$ 23 billion from US$ 8.8 billion in 1991.

Telecommunications

The Philippines has often been seen as the most aggressive deregulator in the entire Asia Pacific region, because of its efforts to radically overhaul its telecommunications infrastructure. The removal of the monopoly status of the long distance carrier, the Philippine Long Distance Telephone Company (PLDT), and the deregulation of the telecommunications market since 1993 have led to new dynamism and there are now many competing companies in the various market segments such as international gateway operations, cellular mobile services, paging services, trunked radio services, and local exchange services. Deregulation has also had an impact on the growth in telephone lines with teledensity increasing from 1.67 telephones per 100 people in 1994 to 2.01 by the end of 1995. The number of phone users doubled in 1996 from 496,862 to 950,000. However, even with this rapid expansion, teledensity continues to be low in comparison to the average in the ASEAN region which is 8 lines per 100 people. Moreover, a large proportion of the country's telephone lines are concentrated in urban areas with many rural areas having no service at all. By the end of 1996, there were nine major carriers providing telephone services, nine international gateway facilities, and five major cellular mobile telephone systems.

The 1994 national IT plan (the NITP2000 agenda is described in the next section) to increase IT diffusion and production in the Philippines envisages a national telecommunications backbone that runs on top of commercial carrier facilities. Specific development programmes in the telecommunications sector also include the Government Information Sharing Technology Network (GISTNET) and the VAN/VAS Development Programme which aims to increase the usage of value-added networks/services such as electronic trading, electronic mail, data transfer and funds transfer.

Deregulation has also helped the diffusion of the internet in the country with the number of internet service providers (ISPs) increasing from only one in 1994 to more than 100

by mid-1997, and intense competition between various ISPs has brought down the cost of access by more than 50 per cent. In metropolitan Manila alone, there were more than 30 ISPs by the end of 1995. PHNet, the country's first gateway to the Internet, is run by the Council for Advanced Science and Technology Research and Development, under the Department of Science and Technology.

National IT Policies

The Philippines IT market was valued at US$ 1.8 billion in 1996 and of this US$ 206 million came from the export of software services. The electronics sector was the largest exporter in the country in 1996 of which 77 per cent was accounted for by the export of semiconductors. Policies for the IT sector have generally concentrated on rapidly increasing exports. Low labour costs and a large pool of English speaking technical manpower have made the Philippines an attractive location for many multinational corporations. The Philippines has also developed an indigenous software industry, and this segment of the IT industry has been explicitly targeted by the government as a potentially high growth industry in its 1993-1998 National Export Plan. The software industry is dominated by small scale firms and many have used joint ventures with foreign firms to obtain new technologies and to create marketing networks overseas. The Department of Trade and Industry also helps local firms find export markets and partner firms in foreign countries. Faced with a small local market, most firms have tended to focus on exports. Software exports from the country have grown from US$ 36 million in 1991 to US$ 206 million in 1996. The ASEAN region is emerging as a major source of contracts for the software industry in the Philippines. Some of the problems affecting the growth of the domestic IT market in the Philippines include poor protection for intellectual property, the lack of a brand image for most domestic firms, and poor marketing capabilities.

In 1990, the Science and Technology Master Plan (STMP) was adopted by the government of the Philippines as an indicative plan to provide clear directions to both public and private sectors on the use of science and technology in the country. This plan involves three strategies aimed at transforming the country into a newly industrialising nation by the end of the century. These include the modernisation of production sectors through technology transfer from both domestic and foreign sources, upgrading of research and development capability, and the development of science and technology infrastructure, including manpower. Information technology is expected to play an important role in this transformation. By 1994, there were only around six personal computers (PCs) for every 1,000 people in the Philippines.

A major IT-specific policy was announced in 1994 in the form of the National IT Plan 2000 (NITP2000) which presents an overall strategy to use IT diffusion to enhance economic development and to make the country globally competitive, in short to achieve the vision of what has been popularly termed as "Smart Philippines" by the year 2000. The National Information Technology Council (NITC) was also established in the same year as a policy coordinating body for the implementation of the NITP2000. The NITC has been set up as a high level steering committee, under the office of the President, so as

to ensure cooperation among government agencies, the private sector and academia. The NITP2000 project envisages action plans for five segments of the economy: telecommunications, industry, government, education and research. Plans for the telecommunications sector have already been described in the previous section. The industry component of the NITP2000 aims to increase IT diffusion in the domestic industry, and also the production of IT goods, particularly exports. However, a recent UNIDO and UNDP funded study criticized the NITP2000 for not fully exploiting the potential linkages between a progressive IT diffusion policy which is the main emphasis of the plan, and existing policies for industry and trade.

In the government sector, there are plans to encourage the diffusion of IT within national agencies and local government units through the National Government Computerisation Programme and the Local Government Computerisation Programme. Government computerisation projects that were implemented from late 1997 include the passport issuance and monitoring system, the nationwide motor vehicle system, a Land Transportation Office management system, the redevelopment of the government insurance system, the streamlining of the social security system, a civil registry system, and the reengineering of the postal system. The government also announced plans to establish RPWEB, a network that would link all government agencies in the country to the Internet, and also form the nucleus of a Philippine information infrastructure.

Plans for the education sector included the development of a pool of competent IT manpower, an increase in the number of IT courses and degree programmes on offer in the country, and to generally improve IT literacy and awareness within the country. For the research community, efforts were to be undertaken to develop alliances between the industry and academia, to identify niche areas for undertaking research and development (R&D), and to provide support to R&D programmes aimed at improving the efficiency and productivity of the government and industry.

Apart from the above initiatives, plans to establish a "cybercity" within the Subic Bay metropolitan area, as a hub for commerce, industry and tourism, supported by state-of-the-art network infrastructure, was announced in 1996. This project aims to link up all government agencies, businesses, educational institutions and households within this area, and to link these with global networks. A liberal tax regime will aim to make the cybercity an attractive option for firms involved in software packaging and distribution, satellite telecommunications and broadcasting, mass media and publishing, and backroom services for high volume transaction businesses such as financial services, airline reservations and government services.

Conclusions

With the implementation of the ambitious NITP2000, the Philippines is hoping to capitalise on new information and communications technologies and industries to drive its economic development efforts and to become a newly industrialised country by the end of the century. However, efforts at translating this goal into reality will depend on the willingness of the State and the industry to work together. As an earlier UNIDO and UNDP funded study noted, a strong institutional framework is a prerequisite to formu-

lating and implementing a coherent information infrastructure policy, and particularly when the plan is as ambitious in scale and scope as the NITP2000.

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India

National and Regional Context

India is a developing country of continental size and population, undergoing a gradual process of economic liberaliszation and globalisation since the early 1990s. Although home to the second largest English speaking technical manpower in the world after the USA, India is a country characterized by vast disparities in income and wealth distribution and in terms of literacy and economic development. India's rejection of the neo-liberal approach to development, and its opting for a mixed economy with State directed planning after Independence in 1947, is clearly reflected in the country's approach to high technology and infrastructure sectors. This approach was given up in favour of a gradual liberalization and globalisation of the Indian economy since 1991 as a result of a major macroeconomic crisis. Since the late 1980s, many other developing economies have also undertaken such a change in policy direction from protectionism towards more market-oriented economic policies in order to boost economic growth and to overcome developmental challenges.

Telecommunications and Networking

The move towards liberalisation and deregulation in the 1990s soon led to the realization that in order for India to become a part of the global economy and for the economic reforms to succeed, particular attention would have to be paid to developing the country's national infrastructure, especially in the area of telecommunications. This was also explicitly recognised by the government's telecommunications policy of 1994. The need to rapidly develop India's telecommunications infrastructure becomes even more apparent when considering the glaring rural-urban divide that characterises the country. The country as a whole had a teledensity of only 0.45 main lines per 100 people by the mid-1980s, and this has increased to merely 1.5 per 100 by 1997.

The first significant reform in the sector since independence was introduced in 1985 when telecommunications services were separated from postal services, and the Department of Telecommunications (DoT) was created to provide telecom services, and the Telecom Commission (then the Telecom Board) was formed to develop policy for the sector. The following year saw the creation of two new companies, the Mahanagar Telephone Nigam Limited (MTNL) and Videsh Sanchar Nigam Limited (VSNL). VSNL was given the responsibility for the DoT's international operations while MTNL took over the Department's local services in Bombay and New Delhi.

The ambitious 1994 telecom policy divided the entire country into 20 so-called circles for basic fixed network services and 18 circles for mobile services, and also led to the establishment of the Telecom Regulatory Authority of India (TRAI), the only independent regulatory authority in the country. One private company was to be licensed in each circle for basic fixed network services while two companies were to be licensed in each circle for mobile services. The policy specifically mandates foreign collaboration but in-

sists on majority ownership by Indian companies. The policy also lays particular emphasis on the provision of services to rural and other less profitable areas of the country. By 1996, cellular and paging services provided by private companies had become operational in many cities, and 22 joint venture companies had set up cellphone networks in the country by the end of 1997. However, private companies have not yet begun operating in the basic services sector. Value added network services or VANS were also liberalised in 1992 and many private and State owned firms have been providing services such as electronic mail, voice mail, data services, audio and videotext services.

The growth in data networking has been slow in India due to its poor telecommunications infrastructure. However, rapid growth in the informatics sector over the last decade and the more recent liberaliszation of value added services have provided the much needed impetus for data and communications networks in the country. A considerable number of general and specialised networks are already in operation or are in various stages of development. The most important among these in terms of its reach as well as technical sophistication is the National Informatics Centre Network (NICNET). NIC is a government body under the Indian Planning Commission that provides information management and decision support services primarily, but not exclusively, to government departments. NICNET provides computing and two-way data communications infrastructure for government departments and related agencies in order to facilitate development planning in the country. It is a satellite-based network using 600 earth stations and connecting government agencies at the central, state and district levels. The NIC's 2000 technical staff have also developed several applications in areas such as multimedia, medical databases, geographical information, and economic planning. Although a government agency, the NIC is increasingly functioning like a commercial entity distributing a variety of third party software products as well as its own applications.

The INDONET is a data network established and maintained by CMC Limited, a State owned software and services company, for the computer user community in the country. The network provides distributed data processing facilities on an all India basis to large organisations using CMC's computers for their data processing operations. Other specialized networks include the SIRNET (the Scientific and Industrial Network), the BTISNET (the Biotechnology Information System Network), and the SoftNET that provides electronic mail, file transfer and video conferencing for software developers. The Educational and Research Network (ERNET) was initiated in 1987 by the Department of Electronics (DoE) to provide computer communications for the academic and research community in India. Applications such as electronic mail, file transfer, remote login, and database access are some of the available services. Several local library networks such as BONET in Bombay, DELNET in Delhi, CALIBNET in Calcutta are in various stages of completion. Thus, communications and data networks have begun to proliferate in the country despite a slow and gradual beginning.

Internet access, although restricted to software developers, universities and research institutions, has been available in India for several years through the DoE's Education and Research Network (ERNET). NIC has also been providing limited internet access to exporters, educational and research institutions. However, full fledged internet connec-

tivity began only in late 1995 with India's long distance telecommunications carrier, VSNL, providing access initially to subscribers in the major cities. With the liberalization of internet access and service provision in 1997, private sector companies and those with up to 49 per cent foreign equity can now provide full internet services. A recent study found that more than 150 Indian and joint venture companies were interested in becoming internet service providers. Prior to this liberalization, lack of coordination and political battles between various government departments had slowed the growth of the internet in the country. As a result, there were only around 50,000 internet connections in the country by the end of 1997. The government has also prevented private investors from building and operating their own high-speed data transmission networks in the country. It has however announced an intention to build a nationwide 2.5 gigabit fibre-optic backbone network over the next five years and costing US$ 333 million. It is expected that local and India-specific content would drive internet penetration in the country to around 1.5 million internet subscribers by the year 2000.

IT Industry

Although the Indian IT industry is still small by international standards, it is one of the fastest growing industries within the country, with a total revenue of US$ 4 billion in 1996-97. Of this, the computer hardware sector was worth around US$ 1.19 billion in 1996-97, and the production of PCs had also grown to around 473,000 in 1996-97 from only 7,500 in 1985. India's globally competitive software industry exported software and services worth US$ 1.1 billion in 1996-97. Software exports are expected to reach US$ 4 billion by the end of the decade. By the end of 1997, the software industry (domestic and export) consisted of more than 700 firms employing around 260,000 people at home and abroad. The industry had a total revenue of US$ 1.76 billion by 1997. Government policy has played a significant role in the creation and development of India's IT industry. Policies based on the economic philosophy of import substitution during the 1970s and 1980s have given way to those aimed at liberalising and globalising the economy in the 1990s. Before surveying the evolution of IT policies in India, we will first discuss the various institutional arrangements for this sector in the country.

The main governmental organisation that is responsible for recommending policies for the informatics sector and for implementing them is the Department of Electronics (DoE). The DoE's role as a strict regulator in the 1970s and 1980s has given way to more industry-friendly, promotional role in the 1990s. The department has been particularly proactive as regards the software industry. For instance, it has set up infrastructural facilities for the IT industry by establishing a number of Software Technology Parks (STPs) and the Electronics and Hardware Technology Park (EHTP) scheme, that provide a variety of tax and other incentives, and has undertaken a range of proactive measures for developing the industry. During 1994-95, the DoE, in coordination with the European Commission, helped establish a company named 3SE (Software Services Support and Education Centre Limited) in order to encourage the use of new software tools and systems development methodologies among Indian software firms as well as to promote cooperation between European and Indian software firms. This company aims to assist Indian software firms in disseminating information on their products and

services, organise seminars and training programmes, and to provide advice on business practices and logistics to those firms wishing to establish international alliances or to locate in Europe (see Dataquest, 1995c). More recently, the DoE has also been involved in the process of establishing an independent Centre for the Diffusion of Information Technology (C-DIT) in order to improve IT consumption in a number of targeted areas such as health and service industries.

The Electronics and Computer Software Export Promotion Council (ESC) is another agency set up by India's Ministry of Commerce (MoC), with representatives from the MoC, Ministry of Finance and DoE, in the late 1980s. The ESC aims to promote software exports through the provision of market information and marketing assistance. Government funded computing organizations such as the National Informatics Centre (NIC), the National Centre for Software Technology (NCST), and the Centre for Development of Advanced Computing (C-DAC) play important roles in new technology development.

The Manufacturers Association for Information Technology (MAIT) and the National Association of Software and Service Companies (NASSCOM) are the organizations that represent India's hardware and software industries respectively. Under the liberalized environment of the 1990s, these lobbies have often worked closely with the government and related agencies in developing the country's IT sector. For instance, joint efforts by the government and industry led to tougher copyright laws and also to the creation of the Indian Federation Against Software Theft (InFAST).

Conclusions

India's policies for the information and communications technology sector have generally been characterised by a narrow sectoral focus. There have been no integrated and coordinated policy attempts at developing a national information infrastructure. The government has mostly been preoccupied with developing an indigenous computer hardware and a software and services industry. However, the development of a variety of data communication networks, liberalisation in the telecommunications market and the rapid growth of India's information technology industry have all led to what may be seen as a de facto foundation for a national information infrastructure.

The telecommunications sector has been the target of some radical reforms in the 1990s, but these are yet to substantially upgrade India's basic telecommunications infrastructure and rapidly increase teledensity in the country. However, liberalization and deregulation have led to the provision of new value added services, mobile telephony and paging servcies and more recently internet service provision has also been liberalised to enable the entry of the private sector. However, rapid growth in internet penetration will depend to a great extent on how quickly India is able to develop its telecommunications infrastructure and a nationwide backbone for high-speed connectivity.

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Turkey

Introduction

Turkey is a country which can best be characterised as one which is making every effort to avoid being left behind in the worldwide move towards information infrastructure. However, it is also a country which has been largely unsuccessful in managing infrastructural developments in recent times. Because of this lack of success it is especially difficult to overcome widespread scepticism about the government's ability to invest sufficiently, to regulate carefully, to manage its interests, and to anticipate the range of affects which other countries regard as necessarily a part of the project to develop infrastructure. Although both popular and official sources repeat the rhetoric of economic development and productivity growth, in effect the policy is based on the perceived need to avoid falling too far behind European standards of infrastructure development.

As we will see, the balance between State and private powers in Turkey ironically resembles more the situation in the USA than Western European countries, not because the Turkish State would not like to take a stronger initiative, but because of their inability to finance and enforce the initiatives they may wish to lead.

National and Regional Context

Turkey is a rapidly expanding economy which is in the throes of major changes, including urbanisation, industrialisation and population growth. It has a tradition of trade with Europe as well as the Middle East, and now is anxiously moving into the position of entrepot with the Turkic Central Asian countries. It has a population with relatively high literacy, but poor capabilities in some skilled areas, especially with regard to the management of complex organisations. Wealth is unevenly distributed both in geographical and social terms.

Its telecommunications system is extensive, but modernising only slowly and in a manner which is heavily caught up in domestic political affairs. Although the process of privatising Türk Telekom began some time ago, and the commitment to do so by the year 2006 is set in the 1997 World Trade Organisation telecommunications agreement, there is still a strong strand of feeling that the State interests should not be sacrificed and that the company in its current form is capable of providing the necessary extension of universal service, especially in the underdeveloped regions of the country.

Economic growth in Turkey has been very strong, averaging around 6 per cent, since the mid-1980s, despite galloping inflation, unstable governments and the parlous state of the region. Although the Gulf War was extremely costly to Turkey, mainly as a consequence of the loss of trade with Iraq, that has not been the only disturbance on its borders. There have recently been wars or major disruptions involving all of Turkey's neighbours: sanctions and instability in Iran; war between Armenia and Azerbaijan; civil conflict in Georgia; war in Chechenia which affected Turkey; corruption in Russia; and severely strained relations with Greece and Cyprus which are legacies of the Otto-

man imperial past. Despite this catalogue of instability, investment in business continues to grow and the business community is anxious to reap the benefits of all forms of modernisation, even if the details of what this means and how these benefits would be used are unclear.

Telecommunications

The Turkish telecommunications industry is dominated by the incumbent national carrier, Türk Telekom. That company grew out of its association with the national PTT to become a wholly State owned independent corporation with a monopoly on telecommunications services. A number of private companies have been active over a long period of time in some sectors, notably equipment manufacturing where the NORTEL subsidiary, Netaş, holds a prominent position in the market.

The telephone system is still marked by inefficiencies which were common in developing countries in previous decades: the density of telephone services is poor in all but the most urbanised regions; the cost of telephoning is extremely high (over twice the European average for long distance calling); and the time and bureaucracy needed to add telephones, change numbers or install new lines is formidable.

Internet activities in Turkey are coordinated by TR-NET, a project which began with a link to NSFnet in the USA. The intention of TR-NET was to provide a backbone of service upon which private sector activities could be encouraged through the activities of multiple service providers. Internet use has long been limited by the saturation of available bandwidth on the small national backbone which serves the three main urban areas: Istanbul, Ankara and Izmir. Since 1997 Turkey has experienced one of the most rapid rates of growth in the use of the internet, albeit from a very small base. Nevertheless, enthusiasm is high, judging from the prominence of journalism and other popular expressions of interest in the internet as seen in group meetings, advertising and computer clubs.

National IT Policies

Turkey has no well developed official information technology policies. In the absence of strong leadership from government, private interest groups have taken the initiative to provide a full information technology strategy. These plans stress the diffusion of computers in the private sector and the establishment of working standards for domestic purposes. The most influential of these bodies is BILIŞIM, an association to promote information systems and their effective use.

Other elements of an IT policy do exist but they are largely unfundable and therefore unenforceable. These include the ambition to increase the use of computers in secondary schools and to exploit the university wide network of academic computers.

Specific NII Policies

The key policy direction relating to national information infrastructure is expressed in a report to the Prime Minister from the National Security Council in 1996. The starting point of this document, the "Developments for Setting up the National Information Infrastructure", was that the government must become involved in the development of the information infrastructure, but it could not do so in the spirit of controlling or limiting developments. Rather, it should set out a framework which affects both legal and economic activity to encourage information technology development. The tone of the report is revealingly resigned. The attitude is that the effects which prevail are so pervasive and so much outside of the control of any national government that the normal sort of intervention, such as efforts to censor the contents of information communicated over the infrastructure, should be abandoned. There is a strong belief that technology will affect national and international law and society and therefore changes to legal structures should take this into account and accommodate information technology. This can be done in a manner in which national interests will be protected. However, these national interests will not emerge without a master plan which will maximise the utility of information technology. The overall goal is to allow Turkey to participate in the international information society.

Policy direction is to be shared by the ministry of transportation and the national science council (TÜBİTAK) who will operationalise information infrastructure activities by including representatives of other public institutions and private interest groups. The main governmental bodies which have been active since late 1996 have been the National Security Council, the Army headquarters, the ministry of transportation, the national planning authority, the higher education authority and TÜBİTAK, along with an umbrella organisation to capture private sector interests. Türk Telekom and the Turkish Foundation for Technology Development are invited to contribute to the exercise, but there is no mention of BILIŞIM.

The whole attitude of the is one of resignation. There is throughout a sense that the reason for engaging in this new coordinated policy is to ensure that the country is able to continue to participate in communication and high technology based activities in the future. There is a recognition that the policy should be dynamic and that a flexible and encouraging stance should be adopted, but this is linked to a feeling that market forces have powers greater than can be withstood.

Conclusion

Turkey, more so than most countries, recognises that information technology has not been a major source of its rapid economic growth since the mid-1980s. Although some individual production units have been successfully computerised, no industry is redarded as being dependent upon information technology for its survival, growth, or even international competitiveness.

Turkish efforts to improve information infrastructure are almost entirely fuelled by comparison with foreign activities and the anxiety that there will be some disadvantage in the future if adequate investment is not made. However, given the country's inability to invest in large scale infrastructural improvements, and given the vigorous position of the private sector, it is likely that the current pattern of sector specific, nationally uncoordinated development will continue.

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South Africa

National and Regional Context

South Africa's huge disparity in income is mirrored by the range of information services and the contrasts in information infrastructure found in various sectors and regions. In general, South Africa not only leads its region in infrastructure, it also holds ambitions to become a regular participant in world-wide information and communications activities. It is that ambition which makes South Africa a particularly interesting case of a country making great efforts to maintain a position as a player in the international information infrastructure.

The legacy of apartheid and the consequent sanctions can be seen in many features of the country's information infrastructure. On the one hand, the necessity to develop independently boosted the opportunities for the development of a domestic hardware and software industry. On the other hand, the costs to consumers was high and few state-of-the-art technologies are available outside of military applications. This forced independent development has also created the conditions where there is a well established IT training and education sector and relatively low dependence on multinational corporations.

Telecommunications

There is a good telephone system including electronic data interchange which is available to the majority of advanced business users, albeit concentrated in only a few areas of the country. Where multinational corporations do operate, there are good routes in place for technology transfer.

In underdeveloped areas and communities of the country, inadequacies of all forms of infrastructure are extreme. Large regions are not served by electricity and have no telephone system. The challenge, as stated by Dr. Jonathan Miller, Director of the Centre for Information Systems at the University of Cape Town, is "to capitalise on its IT strengths to claw its way up the ladder of global competition and at the same time enhance the quality of life of its poorest communities."

National IT Policy

It is because of the disparity that there is in general the need for "a coordinated set of principles and measures agreed by all the major players to maximise the benefits of IT for the nation" (Miller, 1996). The government's reconstruction and development programme refers to the need for information and communications technologies in the overall national policy. There is much enthusiasm for the prospect of an information infrastructure to improve education, health care, employment and civic development.

Whereas the encouragement of widespread diffusion of information and communications technologies must be the main goal, the fragmentation of the society, and even the

imbalances which exist within the relevant professional communities, mitigate against straightforward solutions. The 1997 Telecommunications White Paper lays out a concrete policy for a communications infrastructure, one which is consistent with the goals of the World Trade Organization's ambitions for telecommunications liberalisation.

Currently the South African telecommunications infrastructure is sophisticated and well in advance of the rest of Africa. The fixed line network provides 9.5 lines per 100 people with 70 per cent of lines connected to digital exchanges and a wide array of advanced communication services are offered. Other elements of the infrastructure include a rapidly growing network of cellular telephones, extensive domestic microwave broadcasting infrastructure, international optical fibre links, satellite coverage for both broadcasting and communications, and a national internet backbone. The popularity of the internet has placed the country sixteenth in the world in overall connectivity, but, like most of the rest of the economic infrastructure, it is concentrated in the hands of a small number of people, further aggravating the problem of social inequality.

Nationally, according to 1995 data, the stock of computers stood at roughly 150 mainframes, 10,500 midrange computers and 1.1 million PCs. There were approximately 25,000 IT professionals in the country, 420,000 internet users and 88,000 internet host computers.

South African policy analysts believe that there is an emerging consensus on how to go about building an extensive information infrastructure. The consensus centres on the need for private sector leadership and government guidance on bringing about more widespread services as a first priority. The application areas initially will have to be in the areas of social services: education, health, welfare, and job creation. These guidelines are those largely applied by the OECD, and South Africa has tried to follow them. They include a reliance on the private sector to provide the required investment with the role of government focused on providing a regulatory environment that facilitates rapid growth of all networks. Government is also engaged in promoting interoperability, ensuring universal service, and providing the legal framework for data security and protection of intellectual property rights.

Specific NII Policy

The incumbent telephone services provider, Telkom, is the focus for much of these policies. It is to be given a short period of continued exclusivity in exchange for their investment in extending the scope of services to previously poorly served regions. South Africa has a number of community based information and communications services projects, but as yet these are not integrated into a system which will lead to private sector led competitive services. Government subsidies support these projects, and will continue to do so until universal service provisions are provided.

Since IT accounts for a major drain on the country's overall balance of trade, there is a strong argument for policies which promote local hardware assembly and software development. As African regional consumption of information and communications technologies grows, the prospect of a viable export oriented industry appears more feasible.

The base for industrial development in the sector is strong, although like almost all other features of the society it is highly concentrated both geographically and within the white community.

Conclusion

South Africa is in many ways a peculiar case. The economy, and the majority of the population who live under conditions of economic hardship, is reflected in almost every way as regards information infrastructure. The geographical dispersion of facilities, the education necessary to gain access, the financial resources and even the perceived need on a personal level is sharply divided.

What is especially interesting about the country is that this divide is not only recognised by the government and the society at large, it is the main focus of attention in most areas of economic policy. Unlike most countries, South African intellectuals and policy makers are under little illusion about the supposed miraculous benefits of informatics. Nor do they bother with rhetoric about the gap in national competitiveness. Rather, they have been able to concentrate on the pragmatic tasks of setting priorities for key application areas and of building the basic infrastructure with new techniques to reach the majority of the population.

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Conclusion

We have seen from this review of eight illustrative countries a variety of approaches to information infrastructures. This variety shows how the differing motives for involvement in infrastructure development have affected the form of NII planning. It also reveals how strong the two forms of rhetoric, concerning the productivity payoff and the fear of a widening information society gap, have become.

The eight cases have demonstrated markedly different approaches to the issue of national information infrastructure. Some have been highly integrated and state-directed, such as Singapore, while others have been in the main, industry-led, less coordinated and market driven, such as the USA. The middle ground is occupied by countries like the Republic of Korea with stated goals and strategies but which have a long way to go before they are fully implemented. The Philippines could also be seen as a case in point but here, unlike in Korea, the stated goals and strategies are far removed from the actual reality of implementation. Then come countries with no explicit NII agenda but wherein the elements of an NII have already begun to be formed and the foundation laid by virtue of developments in the IT and telecommunications industry which have often been policy driven or aided. A typical example is India. To the last group belong countries like Turkey and South Africa with limited effectiveness of NII-related discussions at the policy level or even NII-related developments in the industry.

What is perhaps more interesting about the new NII and NII-related initiatives around the world is that the very process of setting up such an infrastructure will have implications for the nature of interaction between the state and industry in many of these countries. The very nature of developments in information infrastructure requires a fresh approach from the state to its interaction with industry. All of these countries have made some progress in bringing about regulatory reform, at least of the telecommunications industry, and most of them have policies which promote the involvement of the private sector in information infrastructure development. For most countries the very idea of private sector involvement in infrastructure development, except as suppliers and contractors to government, is still alien.

The effects of various information infrastructure projects will not be apparent for a long time to come. Even after the lives of millions of people will be changed it will be difficult to differentiate the long term effects of information infrastructures from other features of economic development.

The world is in the midst of a marvellous experiment. As with the best of experimental methods, we will be able to see how different contextual factors affect information use in different countries. We may not be able to prove the case definitively, but in a few years we may know whether strong central coordination is effective, or whether market forces really will combine to create a seamless, compatible, equitable information infrastructure. As we look back on this formative period, we may be better able to appreciate the motives and conditions under which these great new initiatives originated.

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