Chapter 3

SCIENCE AND TECHNOLOGY DEVELOPMENT TOWARD A KNOWLEDGE-BASED ECONOMY

Patarapong Intarakumnerd
Pituma Panthawi

1. INTRODUCTION

Like many developing economies, Thailand has experienced major structural shifts over the past three decades – first moving from an agriculture economy toward a manufacturing exports in the 1970s and then from labour-intensive to medium- and high-technology exports in the 1990s. Electrical and electronic exports have grown rapidly, but their role primarily has been to serve as an assembly facility of these products. Moreover, there is no significant increase in the amount of local technology content in the production of these exports. The major impediment of transformation into a major producer of high value-added products is weakness in the country's science and technology (S&T) competency.

According to a 1999 survey commissioned by the National Science and Technology Development Agency, the total research and development (R&D) expenditure in Thailand was around 0.26 percent of the gross domestic product (GDP), which is relatively low when compared to other developing countries having similar levels of economic development. In the World Competitiveness Yearbook, published by the Institute for Management Development (IMD), a non-profit organization based in Switzerland, Thailand ranks very low in terms of international competitiveness in science and technology.

However, for one particular domain of S&T development – information (and communications) technology (IT) – Thailand has made quite significant progress in recent years. The Thai Government has long recognized the importance of IT as a major economic and social driver. A committee headed by the Prime Minister and responsible for IT policy making was established

more than a decade ago. Currently, Thailand has adequate infrastructure. Many schools throughout the country have free Internet access. Utilization of IT in the public sector has increased. Despite those gains, there are many more goals to achieve.

This chapter analyzes Thailand's competitiveness in S&T compared to other countries in the region and using the concept of the national innovation system, it highlights the weak points in S&T development in Thailand by examining the main actors (such as private firms, government institutions and universities) and their linkages. In addition, the S&T Action Plan (2002-2006) aiming at addressing these weak points is described. Subsequently, prospects and policy recommendations for S&T development are suggested. The second half of the chapter focuses exclusively on information and communication technology, a major component of S&T that has received significant attention in the recent decade. Within this section, IT-2000 and IT-2010, the two national IT policy frameworks of Thailand, are explored.

2. THAILAND'S COMPETITIVENESS WITH REGARD TO S&T DEVELOPMENT

In the 2002 IMD World Competitive Yearbook, Thailand ranks 34, four ranks better than its position the previous year. This was attributed to better rankings in three fields: Government Efficiency (from 39 to 27), Business Efficiency (from 44 to 38) and Infrastructure (from 40 to 38). However, the Economic Performance ranking fell from 15 to 32 (see Table 2.1).

Table 2.1: The Ranking of Thailand's Competitiveness in Four Fields

Fields	1997[1]	1998[1]	1999[1]	2000[1]	2001[2]	2002[2]
1. Economic Performance	28	32	40	15	15	35
2. Government Efficiency	23	36	28	30	39	27
3. Business Efficiency	33	44	42	42	44	38
4. Infrastructure	40	41	38	37	40	38
Overall	31	41	36	35	38	34

[1] from 47 countries
[2] from 49 countries
Source: The World Competitiveness Yearbook 2001, IMD

Regarding competitiveness in science and technology, the ranking of Thailand in the year 2002 was better than the previous year. The ranking of Scientific Infrastructure[1] and Technological Infrastructure[2] was up from 49 to 46 and from 48 to 42, respectively (see Table 2.2). Nonetheless, the rankings were still lower than competitors in the region, such as Malaysia (26 in Scientific Infrastructure and 29 in Technological Infrastructure).

Table 2.2: Science and Technology Competitiveness of Thailand

Fields	1997[1]	1998[1]	1999[1]	2000[1]	2001[2]	2002[2]
Scientific Infrastructure	32	43	46	47	49	46
Technological Infrastructure				47	48	42

[1] from 47 countries
[2] from 49 countries
Source: The World Competitiveness Yearbook 2001, IMD

[1]Scientific infrastructure consists of 22 factors, such as R&D expenditure, R&D personnel, basic research capability, patent, S&T publication, S&T teaching in school, Nobel Prize award, and intellectual property protection.

[2]Technological infrastructure consists of 20 factors mainly concerning ICT readiness. Other factors include technological cooperation, technological development and application, financial resources, and high-tech exports.

One important factor, R&D expenditure, is highlighted to indicate the weakness in science and technology competency in Thailand in comparison with advanced countries, first-tier newly industrializing economies (NIEs) and second-tier NIEs. Currently, gross expenditure for research and development (GERD) as a percentage of GDP of advanced countries, such as the United States and Japan, is around 2-3 percent. That of first-tier NIEs, such as South Korea, Taiwan and Singapore, is around 1-2 percent. For Thailand, which can be considered a second-tier NIE, R&D expenditure in 1999 (the latest figure) was around 0.26 percent. This figure is substantially lower compared to second-tier NIEs, such as Malaysia (0.39 percent), which has more or less the same economic development level as Thailand (see Table 2.3).

Table 2.3: GERD and GERD/GDP of Thailand and Other Countries

Economic Level	Development	GERD (million US$)	GERD/GDP (%)
Advanced Countries	Japan	121,250	3.17
	USA	243,548	2.69
First-tier NIEs	Korea	10,028	2.47
	Taiwan	5,903	2.05
	Singapore	1,641	1.89
Second-tier NIEs	Malaysia	296	0.39
	Thailand	269	0.26

Source: The World Competitiveness Yearbook 2001, IMD; National Survey of R&D in Singapore 2000, Agency for Science, Technology and Research (A*STAR), National Survey of R&D 1998, MASTIC; National Statistics Office, Japan.

The contribution of the private sector in national R&D expenditure is an indicator of countries' economic development and S&T competitiveness. In advanced countries, the private sector contribution in this aspect is higher than first- and second-tier NIEs (see Table 2.4). Interestingly, while both Malaysia and Thailand are second-tier NIEs, the contribution of the private sector in Malaysia is much higher than in Thailand both in absolute and relative terms (US$196 million, or 66 percent [Malaysia] vs. US$124 million, or 47 percent [Thailand]).

Table 2.4: Proportion of R&D Expenditure Between Public and Private Sector

	Private R&D expenditure (million US$)	Public R&D expenditure (*) (million US$)	Percentage of GDP in R&D expenditure (public/private)	Proportion of Private/Total R&D expenditure
Japan	94,730	26,520	0.70/2.47	78
Singapore	1,019	622	0.72/1.17	62
Malaysia	196	100	0.19/0.20	66
Thailand	124	145	0.14/0.12	47

* Including University and public Research and Technology Organization)
Note: Japan (2000), Singapore (2000), Malaysia (1998) and Thailand (1999)
Source: The World Competitiveness Yearbook 2001, IMD

Many factors can be considered as causes of the weakness of science and technology development in Thailand. In the next section, we will apply the concept of the national innovation system (NIS) to systematically analyze the causes that influence each other.

3. NATIONAL INNOVATION SYSTEM OF THAILAND: INSTITUTES AND LINKAGES

Innovation is the offspring of the combination between social activities and science and technology breakthrough. The general perception of the characteristic of innovation is that it generates more productivity, new jobs and better material welfare to serve the needs of specific communities. Since the 1980s, the concept of the national innovation system has been gaining popularity as a core conceptual framework for analyzing technological change, which is considered to be an indispensable foundation of the long-term economic development of a nation.

The NIS concept rests on the premise that understanding the linkages between institutions, especially how these institutions relate to each other as elements of a collective system of knowledge creation, diffusion and use, is a crucial instrument to improving a country's innovative performance. These

institutions include both “things that pattern behaviour”, such as norms, rules and laws (i.e. patent systems and technical standards) and “formal structures with an explicit purpose”, such as firms, industrial R&D laboratories, universities and public R&D institutes.

According to the research triangle context, private firms, Government and universities have the main roles in shaping Thailand's NIS. We shall describe the features of Thailand's NIS by examining both its actors and linkages. The description is based on the R&D/Innovation Survey 2000 (including the country's 200 largest firms), commissioned by the National Science and Technology Development Agency. One important characteristic of this survey is that although it focuses mainly on R&D and innovation, it asks about other important technological activities of firms, which might be more important in the developing country context, such as technology adaptation, engineering and design. Previous literature on science and technology development in Thailand is reviewed in this chapter to enrich the findings from the survey.

3.1 Actors of NIS

Firms

Several studies of Thai firms conducted since the 1980s state that most firms have grown without deepening their technological capabilities in the long run, and their technological learning has been very slow and passive (Bell and Scott-Kemis, 1985; Chantramonklasri, 1985; TDRI, 1989; Dahlman and Brimble, 1990, Tiralap, 1990; Mukdapitak, 1994; Lall, 1998). A recently commissioned study by the World Bank (Arnold, 2000) also confirms this long-standing feature of Thai firms. Only a small minority of large subsidiaries of transnational corporations (TNCs), large domestic firms and small and medium enterprises has any capability in R&D, while the majority are still struggling with increasing their design and engineering capability. For a very large number of SMEs, the key issue is much more concerned with building up basic operational capabilities together with craft and technician capabilities for efficient acquisition, assimilation and incremental upgrading of fairly standard technology.

The findings of the R&D/Innovation 2000 Survey point to the same conclusion: Most surveyed firms conduct activities requiring a shallow level of

technological capabilities, such as simple quality control and testing. Less than half of them have capability in design. Only one third have reverse engineering capability. Less than 15 percent of them have done R&D.

Results of the survey show that the figure for the number of firms performing innovations (20 percent), albeit small, exceeds that of performing R&D (15 percent). Almost half of the surveyed firms (48 percent) that carry out product or process innovation do not conduct R&D formally. This confirms Arocena's and Sutz's (1999) assertion that formal R&D, unlike in the developed world, is not an illustrative and complete indicator of innovativeness in developing countries. Such countries tend to rely on off-the-shelf imported technology mostly in the forms of machinery and turn-key technology transfer from abroad or joint ventures with foreign partners (Intarakumnerd, 2000). This is partly because they have tended to be short-term, very commercially oriented (Dahlman and Brimble, 1990:31). Many of them historically developed from a trading background (Suehiro, 1992), paying attention to quick return rather than the long-term issue of development of technology capability.

Government

We will first examine government policies on the development of science and technology in general, and then we will investigate in more detail public research technology organizations (RTOs) responsible directly for developing the country's S&T capabilities.

Contrary to several countries in the Organization of Economic Cooperation and Development (OECD), where innovation has been given high priority in national policy making and the concept of NIS has been well perceived and implemented (see OECD, 1999), there is no explicit and coherent national innovation policy in Thailand. "Innovation", though mentioned in the Eighth National Economic and Social Development Plan (1997-2001), is not well understood conceptually, nor is the NIS concept. It is only a "buzz word" fashionably spoken among Thai policy makers.

Policies to promote technology development appeared on the agenda quite late in Thailand. In the period of the first four development plans (1958-1981), the science and technology issue was not even given separate treatment. As late

as 1979, the Ministry of Science, Technology and Energy (later Environment) was established, and the Fifth National Economic and Social Development Plan (1982-1986) began to highlight the importance of S&T (Lauridsen, 2000: 24).

The industrial policy of Thailand, which is also fragmented, has not paid attention to the development of indigenous technology capability as an integral factor in the process of industrialization (Sripaipan, Vanichseni and Mukdapitak, 1999:37). Investment policy, especially the promotion of foreign direct investment (FDI), aims primarily at generating employment. Unlike Singapore where FDI is specifically used to upgrade local technological capability (Wong, 1999), there is no explicit and pro-active link between promoting FDI and upgrading local technological capability in Thailand. Trade policy, the most important instrument in Thailand being tariffs, has not been used strategically to promote technological learning like what has been done in other NIEs (Amsden, 1989; Chang, 1994; Lall, 1996). Instead, trade policy was a part of the fiscal policy to reduce domestic demand for imports in the case of balance of payment difficulty. The Ministry of Finance, the dominant agency that controlled the policy, had little knowledge or experience of industry and industrial restructuring (Lauridsen, 2000:16-20).

Industrial policies in Thailand have been limited to the so-called "functional" interventions, such as promoting infrastructure building, general education and pushing exports in general. There have been virtually no selective policies, such as special credit allocation, special tariff protection, targeting particular industries or clusters. The exception was the local content requirement in the automobile industry, which was rather successful in raising local content of passenger vehicles to 54 percent in 1986 (Doner, 1992). Interestingly, there has been no reciprocal performance-based criteria (such as export and local content and technological upgrading targets) set for providing State incentives, such as in Korea or Japan where the governments had embedded autonomy (Johnson, 1982; Amsden, 1989; Evan 1989, 1998; Chang, 1994; Lall, 1996). Investment promotion privileges, for example, are given away once approved.

Moreover, in Japan (such as the case of the synthetic fibre industry in the 1950s – see Ozawa, 1980) and Korea (such as the case of the ship-building

industry in the 1960s – see Amsden, 1997), entries into restrictive sectors were based on technological capabilities of potential firms. In Thailand, on the contrary, such entries were decided by the strength of political connections of prospective firms (Intarakumnerd, 2000).

The dominant orientation of policy and resource allocation for building industrial technology development capabilities since the 1960s has been on the capabilities and resources of scientific, technological and training institutions that were intended to undertake technological activities on behalf of firms. Conversely, policy measures and resource allocations designed to strengthen the technological learning, technological capabilities and innovative activities of firms themselves were rather minimal and ineffective (Arnold, 2000:ix).

The Ministry of Science Technology and Environment has a bigger role in promoting technology development than economic agencies, such as the Ministry of Industry (Arnold, 2000:vii). This imbalance is very different from other NIEs and advanced counries where economic organizations such as the Ministry of International Trade and Industry of Japan (Johnson, 1982), Economic Development Board of Singapore (Wong, 1999), Economic Planning Board of Korea (Chang, 1997) have significant roles in the array of policy and institutional support for industrial technology development.

As for public research and technology organizations, which have direct responsibility for developing S&T capability of the countries, common characteristics can be generalized as follows:

Technological activities of the public research technology organizations mainly focus on R&D, not on building lower level capabilities, such as technology assimilation and adaptation, designing and engineering, which are the technological thresholds faced by most Thai firms (see Figure 1). In this aspect, Thai RTOs behaved differently from those of other NIEs in the 1970s and 1980s when their level of development was more or less at the same level of Thailand. The Korean Institute of Science and Technology and the Industrial Technology Research Institute in Taiwan, for example, emphasized institutional and technical supports for industrial technological capability development within firms, such as helping to solve their operational problems (Hobday, 1996).

Though the industry sector has become more and more important in terms of contribution to GDP and exports, as already mentioned, the Government's budget for research and development has been allocated to development of agriculture technologies much more than industrial technologies. In 1997, R&D expenditure for agriculture sciences was 42 percent while that for engineering and applied sciences was only 6.94 percent of total government expenditure on R&D.

Different from developed countries and other NIEs, development of Thai RTOs since the 1950s has not resulted in progressive specialization. The structural feature of public RTOs exhibits a high degree of multiplicity and limited specialization. There are several institutions doing a number of similar duties, namely, providing technical support services, carrying out applied technology development and transfer, undertaking strategic/basic research and funding R&D. This feature reflects the inability of the Government over 40-50 years to abolish or re-organize existing institutions when new ones are founded (Arnold, 2000:140).

University

At present, there are 24 public universities and 50 private universities. Altogether, Thailand has the capacity of educating 1.1 million students; most of them pursue studies in social science and humanities. The quality of universities and the knowledge level of their graduates are not high compared to other universities in Asia. Their research capabilities are generally unsatisfactory.

Linkages between actors

Linkages among the three actors of the Thai NIS are generally weak and fragmented, as explained in the following:

(a) Weak users-producers linkages.

Different from NIS in developed countries where the linkages between user and producers (Lundvall, 1985) have been emphasized as the common basis for innovation, the R&D/Innovation Survey shows that the intensity of links between producers and users and between producers and suppliers are relatively weak in Thailand. The survey results confirm the study of Arnold (2000), which describes customer-

supplier links in Thailand as short and fragmented ones. Also, as the intra-firm technological capabilities themselves are weak, as already mentioned, the innovation-centre interaction generated from such links is therefore limited.

(b) Weak cooperation between firms in the same and related industries. Not only is the vertical interaction along the value chain weak, the horizontal relationship between firms in the same or related industries is viewed as rather unimportant by the surveyed firms. Cooperative consortiums among firms, as occurring in Japan or Taiwan, to research particular technology or products are very rare in Thailand.

(c) Low technological spillover from TNCs.
Thailand is a major recipient of foreign direct investment in the region; in 2000, US$5 billion came into the country. Nonetheless, unlike Singapore where strong links between TNCs and local firms has been consistently upgraded to help strengthen local technological capability (see Wong, 2000), the links for technological development between TNCs and their subsidiaries in Thailand are rather limited and trivial. Previous studies (for example, Sibunruang, 1986; Kaosa-Ard, 1991) found that the transfer of technology tended to be limited to the operational level, i.e. TNCs tended to train their workers just so that they can efficiently produce goods. There has not been sufficient transfer of technology at higher levels, such as designing and engineering. Little investment from TNCs in Thailand has been made in R&D. From 1990 to October 1998, only 41 R&D projects, of which 22 were foreign firms, were granted investment promotion privilege (Brimble *et al*., 1999: 28).

Similarly, TNCs have not been active in developing subcontractors or giving technical assistance to local suppliers. The reason behind this is inefficiency and backwardness of local supporting industries. Equally important, TNCs lack willingness and effort to devote the resources and time to upgrade local suppliers (Dahlman *et al*., 1991).

(d) Weak industry-university link.

As already mentioned, Thai universities have rather poor research capability and most of their research has a low level of industrial relevance. Linkages between university and industry are based on personal connections between individual researchers and companies rather than organizational commitments. Development of long-term and formal links is still in an early stage. Most university-industry links represent short-term training or ad-hoc use of consulting or research activities rather than longer-term, more extensive relationships. The range of activities and mechanisms remain rather limited both in terms of nature and depth of activities and institutional sophistication of mechanisms (Brooker Group, 1995:19).

(e) Weak links between public research technology organizations and industrial firms.

The Innovation Survey, which includes the top 200 largest firms, suggests that the links between industrial-oriented RTOs and industrial firms in Thailand are rather limited. Only a small number, at the very most 20 percent, of the 1,000 firms surveyed have used the services of any of those RTOs. Moreover, these firms generally view RTOs as relatively unimportant sources of information to their innovation activities. These findings are not so surprising because most RTOs still believe in "linear models of innovation". Unlike the research technology organizations in NIEs, such as ITRI of Taiwan (Hobday, 1996), Thai RTOs have been concentrating on developing technologies for industry and, then, transferring them to private firms, rather than promoting the transferring of people from RTOs to private firms, which is important for deepening technological development capabilities in industry (Arnold, 2000:142-133).

(f) Training by government institutions fails to upgrade technical expertise of firms' employees to a higher end.

There are very limited policy measures designed to stimulate firms' investment in training and skills development. The only incentive

mechanism that is intended to influence firms to invest more in training is the 150 percent tax deduction for eligible training expenditure. From the Innovation Survey, less than 5 percent of firms are aware of the existence of this incentive. More importantly, this incentive subsidizes the types and volume of training that would probably have been undertaken in any case without the tax deduction provision (Arnold, 2000: 114-115). It does not target skills necessary for crossing the thresholds of technological capabilities, which are shown in Figure 1. The fact that many vocational students are unemployed suggests a disconnection between s' firm needs and supply of human resources (Ritchie, 2000:25). Although the Skills Development Department invested heavily to upgrade its vocational training program, its main concern is employment, not technological development of Thailand. Therefore, it targets rather low-end skills, like carpentry, not demanded by large Thai firms and TNCs. This is in sharp contrast with training programmes in Korea and Singapore where higher-level, specialized and "pioneering" types of training are the main focus (Arnold: 2000, 111-112).

(g) Government fiscal and financial incentives are ineffective in stimulating private sector's demand for investment in technology development.

Not many firms have used the Government's fiscal and financial incentives because of three main reasons: First, most firms do not recognize the availability of such incentives. The Innovation Survey indicates that only 2-3 percent of sampled firms knew about the existence of the fiscal and financial incentives. Second, those incentives tend to focus on narrowly defined R&D, excluding a very large proportion of activities that contribute to technology development, such as engineering and design. Therefore, such incentives are not demanded by many Thai firms, which have no capabilities and interest in R&D. Last, these incentive schemes have highly restrictive operation procedures due to concerns about corruption and misuse of public funds. For example, financing organizations demand conventional

types of collateral from borrowing firms (TDRI, 1998; Arnold, 2000).

After examining the three key players of Thai NIS, their overall characteristics can be summarized as follows:

Characteristics of the Three Key Actors in the Thai National Innovation System

Firms	*1. Low technological capabilities of firms in Thailand.* *2. In many cases, there are innovative activities in Thai firms but not the products of formally organized R&D.* *3. Most Thai firms, even large corporations, have a deep-rooted attitude of not developing their own indigenous technological capabilities.*
Government	*Policy:* *1. No coherent and articulated innovation policies.* *2. Policies to promote industrial technology development are not given high priority and virtually are not incorporated in industrial, trade and investment policies.* *3. Unlike in other newly industrializing economies, there have been no selective industrial policies to promote targeted industries/clusters and no reciprocity for State subsidies.* *4. Government has focused its efforts on carrying out technology development activities (mostly R&D) for industry by public institutions rather than supporting technological development within industrial firms.* *5. There is an obvious imbalance between S&T organizations and economic organizations related to technology development.* *RTOs:* *1. R&D oriented technology development.* *2. Most government funding on R&D is allocated for agriculture, not industry.* *3. Absence of specialization in Thai RTOs.*

University

1. *Thai universities produce social science graduates much more than science and engineering graduates. The ratio of the two is 67:33.*
2. *The quality of science and engineering graduates is not satisfactory. Many graduates lack skills to effectively use modern tools and equipment, not to mention developing them.*
3. *The number of Ph.D. and Master's degree graduates in science and engineering per year is very low. In 1998, Thai universities produced only 89 Ph.D. graduates, of which only three were in engineering.*
4. *The overall ranking of Thai universities and that of institutions specializing in science and technology are low compared to counterparts in the Asia-Pacific region. According to Asia Week magazine's ranking of institutions in 2000, leading Thai universities placed below 25.*
5. *Thai universities have a weak research culture and capabilities. This is evident by the few publications of research in internationally recognized journals. According to the Science Citation Index, the number of publications by Thai researchers is three times less than that of Singaporean researchers, whose country has a population 20 times less than Thailand.*
6. *Within this rather limited research capacity, the amount of research that has industrial relevance has been even more limited because basic research is given higher priority.*

4. S&T ACTION PLAN (2002-2006)

To address the serious weaknesses in its science and technology development, the Thai Government drafted an S&T Action Plan (2002-2006). This plan differs from previous S&T plans in three ways:

1. Previous plans were written as "comprehensive" plans. They tried to include and achieve all aspects of national problems that were assumed to be relevant. By design, this plan is a "strategic" one: It addresses only the very issue strategically important to the future of Thailand, i.e. long-term and sustainable competitiveness of the country.
2. Previous plans were very much supply-sided. They were designed to strengthen S&T for the sake of S&T. People who wrote the plans assumed that by reaching this goal, there would be spillovers to other sectors in the economy. This plan, instead, will be more balanced. While recognizing the importance of the need to improve S&T capabilities of the country, it gives very high priority to the demand side, that is, how S&T can be a catalyst or an enabling factor helping the country to solve economic and social problems in general and to increase Thailand's competitiveness in particular.
3. Related to the first point, previous plans were very general. They neglected that each industry/cluster contains different actors and has different technological learning processes and innovation systems. Apart from addressing general issues, such as promoting S&T knowledge creation and diffusion, this plan has cluster/sector-specific characteristics.

The vision of the plan is the development of S&T via cooperative networks both inside and outside the country aiming at building up indigenous capabilities in order to attain higher value added productivity, better quality of life and sustainable development. Its mission is to create and strengthen networks both domesticly and overseas and build up R&D and innovation competency of S&T personnel to facilitate technological capability development in the private and other sectors.

The S&T Action Plan has four main objectives:

1. To enhance competitiveness through development of firms' technological capability in areas in which Thailand has good potential or opportunity for competition in the world market.
2. To strengthen S&T manpower to be able to effectively serve economic and social needs.
3. To reform the management system and S&T policy planning process to be more effective.
4. To promote equality for S&T learning opportunity throughout the society.

In order to achieve these objectives, five strategies and corresponding targets and programs have been designed (see Table 4.1).

Table 4.1: Five Main Strategies of the S&T Action Plan (2002-2006)

Strategy	Target	Programme
1.Enhancing competitiveness of the private sector through development of innovative clusters and mega-projects using more risk-taking financial and fiscal incentives and government procurement as key stimuli.	1.Increase the export value of technological products. 2.Increase the granted patents of Thai people/companies (within Thailand and abroad). 3.Increase the expenditures in technological capability in private sector.	Cluster development fiscal/ financial measure for supporting R&D in the private sector. Mega-projects for technological capacity and innovation development. Enhancing S&T organizations to support the private sector.
2.Reforming the educational system to create/develop S&T human resources to meet economic and social needs, both quantitatively and qualitatively.	1.Increase the number of scientists and technologists (per 10,000 labourers). 2.Increase the number of researchers (per 10,000 labourers). 3.Improve the quality of scientists and technologists to meet entrepreneurs' needs.	1.Education reform to create capable and innovative personnel. 2.Developing S&T personnel. 3.Promoting linkage between S&T community and society.
3.Employing performance based management and creating strong linkages among agencies to facilitate effective policy formulation and implementation.	1. Increase the efficiency in public services (e.g. greater serviced population, less time cycle). 2.Increase the satisfactory rate on public service.	1.Establishing performance-based management. 2. Enhancing policy formulation and implementation system.

Strategy	Target	Programme
4.Adjusting R&D funding systems and exploiting new sources of funds to effectively and sufficiently serve economic and social needs by promoting participation in managing and funding R&D projects from the business sector.	1.Increase the budgets in supporting R&D projects in the private sector compared to that in the public sector. 2.Increase laboratory utility to meet full capacity.	1. Improving the R&D funding system to meet economic and social needs. 2.Raising R&D funding from sources other than the government budget.
5.Expanding ICT facilities around the country and creating community S&T resource centres to ensure that everyone has equal opportunity for S&T learning.	1.Improve the percentage of Internet accessibility. 2. Ensure that every district can produce/manage own local content for public distribution within 2004.	1.Expanding information accessibility via telecommunications infrastructure. 2. Creating community resource centres.

The S&T Action Plan sets out 10 first-batch projects that need to be implemented:

1. Automotive cluster development
2. Increasing capability in food industry
3. Textile and clothes cluster development
4. E-industry
5. Creation and development of S&T personnel for competitiveness
6. Nurturing S&T personnel through mega projects
7. Enhancing S&T management system via personnel rotation
8. Building up laboratory network (for full capacity utilization)
9. Establishing community resource centres
10. Improving financial incentives for R&D for commercial purposes

These projects will tackle shortcomings in the Thai NIS, especially weak linkages between main actors in the system. Under the industrial cluster concept, linkages between government institutes, universities and private firms will be facilitated in three targeted industries (food, automotive and textiles). For the e-industry project, information technology will be seriously applied to make lean production systems and facilitate supply-chain development in manufacturing. The remaining projects will tackle other important problems in the NIS: personnel, finance, management and data.

5. PROSPECTS AND POLICY RECOMMENDATIONS FOR S&T DEVELOPMENT

Policy implications that might be useful for addressing weaknesses outlined in Section 3 are suggested here.

The Government should plan and implement policies that help to address the weakness and fragmentation of NIS. The capability of significant actors (such as the Government, private firms and universities) must be seriously enhanced and "systemic failure" (the failure of actors of the NIS to work in a system-like manner) avoided.

Specifically, a coherent and explicit national innovation and technology development policy should be formulated, and it should be an important integral part of national trade, investment, industrial and macro-economic policies. Selective technology policies to support particular sectors/clusters should be devised and implemented based on strict performance-based criteria. The Government should make more effort to promote technology development within firms rather than doing technology development on behalf of firms. Government measures (financial and technical supports) have to be specific enough to respond to firms' technological needs and to help them cross the thresholds of their capabilities. In order to strengthen linkages between public RTOs and universities and the private sector, performance of RTOs and university should be evaluated not only on the basis of academic excellence but also on the intensity and success of interaction with the private sector.

If the Government aspires to carry out these tasks and to act as an important and effective actor in the NIS, institutional reform of its bureaucracies is needed. Bureaucracy should be insulated enough from political pressure of vested-interest groups and, at the same time, be able to cultivate favourable cooperation with other actors of NIS. Also it should be run by capable and dedicated government officials committed to common goals. Recruitment and promotion based on meritocracy, like in Japan and East Asian NIEs, should be adopted. In addition, to attract bright people to the bureaucracy, the salary packages, intrinsic job satisfaction, perquisites, job security and prestige have to be similar to the rewards given by the private

sector. To address the coordination problem within the bureaucracy and between government and private firms, rotation of personnel among government agencies and between government and private firms should be encouraged.

The suggested government reforms are not impossible. In the beginning, Thailand is not required to transform its whole bureaucratic system, but it can focus its efforts on economic ministries and agencies that would play significant roles (in terms of policies or effects on other actors) within its NIS.

6. ICT DEVELOPMENT OF THAILAND

In 1992, the first information technology policy-making body, the National Information Technology Committee (NITC), was established. The main objective of this committee is to promote the development and use of IT in Thailand for economic and social well being of the country at large. The committee is chaired by the Prime Minister and consists of high-ranking officials from various government organizations, representatives from the industry and individual experts. Over the years, NITC has set up many subcommittees, each to take a particular area of responsibility, such as the subcommittee on drafting electronic transaction law, the subcommittee on drafting computer crime law, the subcommittee on IT for the disabled and disadvantaged, the subcommittee on IT utilization in the public sector, the subcommittee on IT human resource development, the subcommittee on IT policy planning and Thailand's Internet policy task force, just to name a few.

In October 2002, the Ministry of Information and Communications Technology was instituted. This ministry is, by no means, intended to be a replacement of the NITC. Rather, these two bodies are complementary to each other and will closely work hand in hand. That is, the NITC will maintain its role in IT policy making, while the ministry will take charge in converting policies into actions and practices. The Ministry of ICT is indeed the "champion" for ICT matters that Thailand has been longing for. By having this ministry in place, Thailand can effectively expedite the policy-to-action conversion process, orchestrate ICT-related activities of various agencies to eliminate unnecessary redundancy, maximize efficiency and effectiveness and ensure adequate allocation of resources.

However, the establishment of the Ministry of ICT has led to a reform of NITC's structure. The reform was approved by the Cabinet in January 2003, and it aims at creating a link between the ministry and NITC. That is, the Minister of ICT was appointed a Vice Chair[3] and the Permanent Secretary for ICT was appointed the Secretary. Furthermore, there were some changes on the member bodies. Also, the name of the committee itself was changed from the National Information Technology Committee to the National Committee on Information Technology and Communications.

During the past decade, NITC (as it was previously called) has worked on several policy matters. Its work includes drafting the IT-2000, the first national IT policy of Thailand, and subsequent IT-2010 and its five-year master plan. The content of these policies will be discussed in the following sections.

7. IT-2000: THE FIRST NATIONAL IT POLICY

In February 1996, the first national IT policy of Thailand, IT-2000, which was proposed by NITC, was approved by the Cabinet. IT-2000 was a five-year policy framework spanning from 1996 to 2000. In essence, the policy discusses three foundations or fundamental prerequisites that must be in place to enable Thailand to take a full advantage of IT in order to become a key sustainable economic power in Southeast Asia and, at the same time, to provide social equity and prosperity for all. These three fundamental prerequisites are:

- National information infrastructure (NII)
- A well-educated population and adequate IT human resources
- A "dare to dream and resolve to act" commitment

These critical prerequisites are translated into three corresponding national agendas, described as follows:

[3] The committee has three Vice Chairs: the Deputy Prime Minister (selected by the Prime Minister), the Minister of ICT and the Minister of Science.

Agenda 1 - Invest in an equitable information infrastructure to empower human ability and enhance life quality

Without a doubt, equitable information infrastructure is a critical prerequisite that Thailand should have before the potential of IT can be fully and evenhandedly realized. IT-2000 emphasized the importance of information infrastructure that is universally available and accessible to all citizens at an affordable cost despite their location. The term "information infrastructure" used in IT-2000 refers to not only nationwide telecommunications facilities but also related equipment and technologies including, among other things, telephones, fax machines, computers and peripherals and software. IT 2000 described telephone services and nationwide high-speed telecommunications backbone as the most basic building block that must be first put in place. This infrastructure-building agenda results in two strategic directions, which were, in turn, converted into four policy recommendations, each directed by a specific set of goals:

Strategic directions

- *Wire rural Thailand as necessary to support the Government's major policies to create employment and distribute wealth to rural regions of the country, open up new opportunity and equality for education and personal development, create a more open and equal access to basic public services.*
- *Reform the Telecommunications Act to make it more relevant to modern technological and global business environments.*

To accomplish the above two strategic directions, IT-2000 proposed the following four policy recommendations.

1. *Embark on a five-year Rural Thailand Communications Expansion and Modernization Programme.*
   - Install telephone lines for at least 12,000 remote tambons[4] and villages by investing approximately 6,000 million baht a year for five consecutive years, in order to expand the service coverage to the whole country by the year 2000.

[4] Tambon is a group of villages.

- Provide one public telephone booth to every village with more than 20 households and increase the public telephone penetration rate in the rural area to more than 2:1,000 population.
- Provide data transmission services to business entities of all sizes in both urban and rural area throughout the country with the minimum speed of 64 kbps.

2. *In all future major communications projects, the Government must ensure a reasonable share of the benefits be given to the rural region.*
   - For the six million-telephone line expansion project described in the Eighth National Economic and Social Development plan and other projects, the Government must ensure that an adequate share is given to satisfy the needs of remote rural residents.
   - All projects intended for the rural regions must reflect actual needs of all citizens by giving them an opportunity to participate and have their voice heard.

3. *Establish an independent telecommunications regulatory body.*
   - Through legislative reform, establish an independent telecommunications regulatory committee to take charge in facility and pricing regulation.
   - Encourage participation from the private sector in information-infrastructure building and service expansion and promote open competition.

4. *Review and reform existing Telecommunications Acts and other related Acts.*
   - Establish a flexible telecommunications regime that is suitable for the current environment where technologies are changing at a rapid rate and global competition is intensified.
   - Set up a legal infrastructure necessary to promote IT utilization among people at large.

Agenda 2 - Invest in people to build a literate populace and an adequate information technology human resource base.

Without a doubt, having national information infrastructure put in place is necessary but not sufficient for a country to fully realize the benefits that information technology can possibly provide. Infrastructure must, by all means, be coupled with useful and relevant content and applications that all people can use. The country cannot, and should not, rely largely on imports for content and applications if Thailand wants to have a sustainable economy and society. In other words, local IT manpower must be developed and nurtured to promote local creations of both content and applications.

In addition, Thailand also needs educated, IT-literate citizens who have enough capability to take full advantage of technologies, content and applications brought to them by the NII. Education and knowledge will bring in more consumption, which, in turn, stimulates infrastructure expansion. Infrastructure expansion will then provide more education opportunities, for example through distance learning, to the people. Apparently, human resource development is one critical factor to success. This human resource investment agenda is translated into two strategic directions and three policy recommendations, as discussed below.

Strategic directions

- *Accelerate the supply of IT manpower at all levels to eliminate the current critical shortage and to meet the expected huge demand growth in the future.*
- *Make IT an integral tool in education and training at all levels. The use of IT in education must not be restricted to science and technology but include the humanities and the arts as well.*

The following three policy recommendations, each with its specific set of goals, are derived from the directions previously mentioned.

1. Implement a National School-Information Action Programme.

- Provide microcomputers to every public school throughout the country. Ensure a minimum computer-to-student ratio of 1:80 for primary students and 1:40 for secondary students.
- Continuously invest at least 1,000 million baht annually on hardware, software and IT training for schools to effectively develop, operate and maintain their IT capability. A portion of this investment must be used to provide at least 30,000 microcomputers to schools, some with network accessibility.
- Connect all universities, colleges and then schools to ThaiSarn or other Internet networks to enable students, teachers and faculties of various education institutions to communicate and share information resources among themselves as well as with other sources in and outside of Thailand.

2. Establish a National Interactive Multimedia Institute to facilitate the development of educational courseware and application software.

- This National Interactive Multimedia Institute will take the responsibility of design, development, outsourcing, dissemination and distribution of interactive multimedia technologies, courseware and interactive Computer Aided Instruction (CAI)/Computer Aided Learning (CAL) packages to schools. The responsibility will also include necessary licensing and commercial package adaptation.
- Provide an annual budget of at least 400 million baht for technology and courseware package development. The content presented should reflect diverse local wisdom and knowledge and an emphasis should also be put on promoting a localized information service industry.
- Disseminate these courseware packages throughout social sectors, within and outside schools, for both traditional education as well as professional and specific training. Disadvantaged/underprivileged schools should receive special technological and managerial assistance to enable them to make the most effective and efficient use of their limited resources.

- Make a full use of large, resourceful and centrally located schools, colleges and universities by establishing long-distance learning facilities from these institutions.

3. Intensify IT manpower production at all levels.

- Increase the number of engineers and technicians in IT. The number of telecommunications and computer professionals must be doubled within five years.
- Improve IT curricula and materials used in IT courses of colleges and universities.
- Establish effective measures to retain and recruit IT professors, including recruitment from overseas. Immigration laws and regulations will have to be modified to support this goal.
- Encourage private sector participation in the provision of secondary school and college education, particularly for IT education and training.

Agenda 3 - Invest for good governance.

The “dare to dream and resolve to act” mission can never be accomplished without good governance in action. Though the determination to move the country forward by means of IT requires a strong participation from all parties, the Government still has a prime role to make that happen. The Government should be a prime moving force in both the NII building and human resource development agendas to attract involvement from the private sector. Further, the Government should anticipate all possible negative side effects that could result from the changes brought in by IT and install all necessary preventive and defensive mechanisms accordingly. IT should be an equitable social and economic enabler to, not only to a particular group but to all people. In other words, the Government should ensure that IT will result in a decrease, as opposed to an increase, in social and economic gaps.

As importantly, the Government should also fulfil its responsibility of being a role model to the society by making an effective use of IT across all governmental agencies for the purpose of operation and service provision improvement. Perceivable improvement of government services enabled by IT will surely be an effective agent to drive positive attitudes toward IT and IT

use. IT 2000 indicated two strategic directions, coupled by four policy recommendations, for this "invest in good governance agenda". The directions and policy recommendations, as well as a set of goals for each particular policy are described below.

Strategic directions

- *Seize and make fuller use of new opportunities offered by IT by all public agencies in order to deliver good and efficient services to all citizens, whereby setting a good example as an active IT user to society, while simultaneously improve substantially the effectiveness of governance as well.*
- *Provide top priority supports in particular to SMEs everywhere in order to build a strong and thriving local information industry from hardware, software and content to a whole range of information and other necessary supporting industries.*

To achieve the above two strategic directions, IT-2000 proposed the following four policy recommendations:

1. Launch a nationwide Government Informatization Programme

- Allocate an annual budget for government IT investments, with the minimum amount equivalent to 3 percent of the annual budget spent on total personnel expenditure. Two thirds of this budget should be spent on the provision of computers, network devices, software and databases, while one third should be spent on government human resource development and training in relation to utilization of IT and maintenance of databases.
- Allocate the above budget to various public agencies as evenly as possible, meaning that the amount received should be in proportion to the agency's annual personnel expenditure. This budget should be considered separate from any large IT investments the Cabinet may grant to any particular agencies on a case-by-case basis.
- Allocate an annual budget of at least 200 million baht for the development of common software applications, such as applications for

accounting, human resource management, e-mail, public information search, online tax services, registration services or any other public services.

- Provide as many electronic public service kiosks, for example by using ATMs, as possible to ensure equal access to public services to all people.

2. Make IT planning an integral part of the annual government budgeting exercise and IT policy research an ongoing effort.

Promote continuous policy research by NITC with the objectives to:

- Identify needed directions and policy decisions to assist public agencies in their IT planning.
- Gain in-depth understanding regarding social consequences of IT, particularly negative ones, in order to promptly take preventive and/or defensive actions.
- NITC together with the Budget Bureau will set up comprehensive guidelines to direct all government agencies in their making an IT budget plan and proposal.
- Consolidate all public departments' plans into the overall National IT Plan, which will describe in detail each department's goals and objectives, budget allocation, activities to be taken, previous year's results, problems and obstacles and recommendations every department should submit a rolling, three-year forward procurement plan that indicates its estimated IT expenditure, planned activities and expected outcomes.

3. Support the development of a strong local information industry.

- Ensure continuous and adequate investments in R&D and technology diffusion in the area of hardware, software, information networks, multimedia, manufacturing technology, provision of services and applications.
- Encourage strong participation from the private sector in all aspects of IT development, including development of NII, manufacturing of IT service devices, development of multimedia technologies, IT R&D,

technology diffusion and development of human resources by providing tax/financial incentives, financial resources and outsourcing government IT projects to the private sector. The Government can also promote IT utilization within the private sector.

- Involve local information service industries in major software development and IT training projects of the Government. To ensure transparency, fairness, quality and compatibility, every government agency should adopt a standards system for development practice.
- NITC should closely monitor local and global technological trends in order to effectively propose appropriate strategies and measures to promote a domestic information industry.
- Strengthen public organizations, such as NECTEC, in order to become information resources and a forum for exchange of knowledge and experiences within and across IT manufacturer and user groups and in both public and private sectors.

4. Promote and support electronic means for citizens and businesses to interact or trade with Government, among themselves or with the world community.

- To enable Thailand to become a regional trading and manufacturing center, the Government should speed up the adoption and utilization of Electronics Data Interchange in international trade by facilitating EDI standards development and promoting the use of EDI in major areas, such as public administration, manufacturing, finance, trade and transportation.
- The Government should consider setting up a Government Information Network (GINet) with an emphasis toward a more effective and efficient government and better public services through electronic means.

8. THE EFFECTS OF IT-2000

After IT-2000 ended, NITC requested an independent group of researchers to conduct an evaluation study. The purpose of this study was to compare the actual performances of the country within the IT domain against the proposed goals expressed in IT-2000. In sum, the research results indicated that Thailand made significant progress within a few years with respect to information infrastructure. That is, the country's telephone penetration was increased tremendously. The telephone line service coverage expanded to all tambons around the country; public telephones are now available in all villages. And through optic fibre cable and microwave technology, the Telephone Organization of Thailand (TOT) now provides communication services with a minimum speed of 64 kbps.

In addition, there has been a significant change with respect to the regulatory and legal infrastructure. In February 2000, the Organization to Allocate Radio Frequency and Regulate Radio and Television Broadcasting Act was enacted. This Act mandates an establishment of an independent telecommunications regulatory body called the National Telecommunications Commission (and also a broadcasting regulatory body called the National Broadcasting Commission). The actual set-up of this committee is still an ongoing process, yet is expected to be completed soon. Other laws in addition to the Organization to Allocate Radio Frequency and Regulate Radio and Television Broadcasting Act have also been developed. That is, the Electronic Transaction Act was enacted in April 2001, while the other four IT-related laws – Universal Access, Computer Crime, Data Protection and Data Privacy – are on the way.

With respect to people investment, there has also been obvious progress. Research conducted by the Ministry of Education indicates that by the end of 1998, the computer-to-student ratio was 1:84 for primary school level and 1:53 for secondary school level (compared to 1:80 and 1:50 targeted in IT 2000). Also, by the end of 2000, almost all universities were connected to ThaiSarn, while more than 3,000 schools were connected to SchoolNet. But on the contrary, the plan to establish the National Interactive Multimedia Institute has not been accomplished due largely to budget constraints. Though the institute has not been founded, many multimedia for learning and CAI

development projects have been implemented by several entities. In addition, in August 1999, the Education Reform Act was enacted. This reform clearly expresses the importance of IT in education. However, at present, IT manpower demand in Thailand is still greater than the supply. Apparently this disparity between demand and supply needs to be resolved.

Regarding the third agenda on investing in good governance, there has also been perceivable progress. For example, in 1999, based on an NITC proposal, the Cabinet demanded every public ministry and department to appoint a high-ranking official (i.e., deputy permanent secretary for a ministry and deputy director general for a department) as the Chief Information Officer (CIO) of the organization. The responsibility of a CIO includes drafting of the organization's IT master plan and transforming relevant national IT policies into organizational actions. In recent years, there has been a visible improvement regarding IT utilization in the public sector for both internal operation and public service provision purposes. Many of the public services are now available online. GINet was also established to provide secured, network services for government organizations. Also, an agency called Software Park was set up to promote and support the Thai software industry.

In sum, after the release of IT-2000, Thailand moved a long way in relation to information infrastructure, human resource and good governance developments. However, it could be regarded that the accomplishments within the human resource and good governance developments are of less degree in comparison to that of the infrastructure building. For the human and good governance building agendas, though obvious progress has been made, there are still a number of goals that have not been accomplished.

9. FROM IT-2000 TO IT-2010

After IT-2000 successfully provided a framework for subsequent policies and projects, IT-2010, a national IT policy framework governing a ten-year period was drafted and approved by the Cabinet in March 2002. As discussed in the previous sections, IT-2000 focused on three fundamental prerequisites that must be put in place; IT-2010, however, extends the focus to include not only the required foundations but application domains in which IT should be

utilized. More importantly, the ultimate vision of IT-2010 is not on the technology itself but the effective use of IT that would lead to sustainable social and economic development of the country.

The ultimate vision expressed in IT-2010 is to bring Thailand into a knowledge-based economy and society, an economy and society in which creation, collection, dissemination and utilization of knowledge are considered major tools of economic and social development. To turn this vision into reality, IT-2010 identifies three guiding principles that must be followed:

- *Invest in knowledge-based human capital*
- *Promote innovation*
- *Invest in information infrastructure and information industry promotion*

In addition, three measurable goals are targeted:

- *Increasing national technological capability, expressed in the UNDP Technological Achievement Index, from being in the "Dynamic Adopters" to the "Potential Leader" category.*
- *Increasing the proportion of "knowledge workers" using the International Labour Organization (ILO) classification standard, from 12 percent (as of 2001) to 30 percent (to match the average knowledge worker proportion of the OECD country members of the year 2001).*
- *Increasing the proportion of knowledge-based/knowledge-intensive industries, adopting OECD classification standards, to 50 percent of the overall economy (to match the average knowledge-based industry proportion of the OECD country members of the year 2001).*

As mentioned previously, in addition to the fundamental principles, IT-2010 also identifies specific application domains in which IT should be utilized. These application domains are called "flagships", which will be individually presented in the following paragraphs.

Flagship 1: e-government

E-government flagship takes a focus on the utilization of IT within the public sector, which includes central, provincial and local government organizations. The ultimate objective is to develop good governance that will help strengthen the overall competitiveness of the country for a

better quality of life for all the citizens. Two specific goals are associated with this flagship:

- By 2004, government internal administration (back office) must be fully computerized.
- By 2005, at least 70 percent of public service provision (front office) will be offered online and 100 percent will be online by 2010.

Flagship 2: e-commerce

The overall objective of this flagship is to strengthen the competitiveness of Thai industries by means of electronic commerce. According to IT-2010, primary attention should be put on e-commerce for exports, e-commerce for trade and provision of services and e-commerce for domestic consumption. It is extremely critical to put an emphasis on equal distribution of benefits to the people at large.

Flagship 3: e-industry

This flagship attempts to promote the utilization and development of IT within the private sector to enable the private sector to become knowledge-based industry by 2010. In doing so, IT should not be utilized exclusively within any particular functions but all functions connectedly, including office administration, production, logistics and marketing.

Flagship 4: e-education

The objective is to develop and strengthen people capital in all levels to enable the country to be a knowledge-based society. Five specific goals are associated with this flagship:

- By 2010, all schools should have an access to computer-based network and are able to equally and effectively make full use of the network for educational purposes.
- By 2006, at least 10 percent of instructions conducted in educational institutions should be assisted by computers and/or any other information technologies.
- Educational institutions should supply the industry with adequate human capital including computer, software, telecommunications and

IT scientists, engineers and researchers. The institutions should also be a resource for technological and industrial innovations.

- Innovation for education itself should be promoted to ensure quality and compatibility between education and industry requirements. In addition, IT curricula should be developed in a way that will stimulate application development and technological transfer to the industry.
- By 2010, 50 percent of the workforce should receive some type of professional skills training through an IT network.

Flagship 5: e-society:

E-society refers to the attempt to use IT for quality-of-life improvement, knowledge-based society development and, importantly, digital divide reduction. Three specific goals are indicated:

- By 2010, each and every Thai citizen will have equal access to quality IT services at affordable costs. This IT accessibility will, in turn, lead to improvements in employment opportunity, quality of life and environment. Further, content development should be promoted with an emphasis put on information requirement of the local people. At least 10 percent of the content created should be done locally.
- Local and older-generation knowledge and wisdom should be accumulated, articulated, treasured and augmented by modern knowledge and technology to form national and international knowledge.
- By 2010, at least 50 percent of all the villages in Thailand should be a knowledge-based society where knowledge is continuously developed, the economy is strong, the society's members are debt-free, quality education is provided to all, good public services are available, crime does not exist and senior citizens are well taken care of.

IT-2010 clearly indicates that the development of the five flagships should be done in synergy. For example, resources should be shared to reduce investment redundancy, demand-supply relations among the flagships should be created to keep exports to the minimum, physical and information networks should be built to urge close collaboration and cross cooperation within and across public and private sectors should be encouraged.

The three guiding principles previously presented and the five flagships are intertwined and should all be put into the big picture. For example, the development of e-education will have a positive effect on human capital development. Likewise, investment in infrastructure will have a positive effect on all flagships. More importantly, the principle to promote and support local IT industry must be given a high priority. Otherwise, the development of the five flagships can possibly lead to greater negative export balance.

Besides the three guiding principles and five flagships, IT-2010 also indicates a set of so-called "key success factors" that must be accommodated into all IT policy developments and implementations as well. These key success factors are as follows:

1. Content and knowledge creation must receive more or at least equal attention in comparison to infrastructure and hardware.
2. Continuous human resource development is a must. This should be done through both traditional (in school) and non-traditional education, including short-term training to elevate capability of the workforce in order to become the knowledge workers.
3. Digital divide problems must be tackled by creating digital opportunity to all. It is important that all dimensions of divide, i.e. infrastructure divide, literacy divide, cultural divide and management divide, are recognized.
4. IT leadership must be emphasized and inserted in IT policy development and implementation at all levels, starting from the Prime Minister through his role as the chair of national IT policy-making body.
5. Linkage between universal access policy and telecommunications and broadcasting policy must be ensured. Technological convergence should also be put into consideration to optimize the utilization of resources.

ICT Master Plan (2002-2006)

As previously mentioned, IT-2010 provides a policy framework to guide Thailand during the first decade of the 21st century. In addition to IT 2010, NITC also drafted a five-year plan called National ICT Master Plan 2001-2006 identifying visions, missions, objectives, strategies, plans and

timeframe for the first five years of IT-2010. This ICT Master Plan was approved by the Cabinet in March 2002. It is intended to provide a guideline for government agencies and other related organizations to draft their five-year ICT strategies accordingly. By doing so, ICT developments of all related parties will be well orchestrated.

SWOT (Strengths, Weakness Opportunities, Threat) analysis was adopted to identify strengths, weaknesses, opportunities and threats in Thailand in relation to ICT development and utilization. Based on these findings and other related information, national ICT strategic agendas for the next five years are described as follows:

Strategy 1: Elevate Thai ICT industry to become a regional leader.

Goals

1. By 2006, expand the software industry value to 90 billion baht a year with 75 percent contributed to exports.
2. By 2006, have at least 60,000 software developers; 30 percent of this workforce should be certified developers.
3. By 2003, establish a Software Industry Promotion Agency.
4. By 2006, a government budget with a minimum amount accumulated to 5 billion baht should be spent on software development projects with the purpose to create the market and opportunities for local software industry.
5. Provide open-source software with the value of at least 50 percent of the total software market.

Strategy 2: Utilize ICT to enhance quality of Thai lives and society.

Goals

1. By 2005, at least seven telephone lines with the minimum speed of 32 kbps should be provided to every community throughout Thailand.
2. By 2006, broadband services should be provided to every province at a reasonable price.
3. Decrease domestic leased-line prices to reflect technological advancement.

4. By 2006, at least 70 percent of the disadvantaged and underprivileged population should have access to ICT services.
5. By 2006, an ICT service centre should be established at every sub-district.
6. By 2006, Thailand should have at least 300,000 IT-literate teachers, 70 percent of which should be in the provincial areas.
7. By 2006, a radio broadcast station should be set up in every province, and community radio programmes should also be provided.
8. By 2004, each sub-district should be able to publicize the content made locally.
9. An organization responsible for ICT security should be set up.

Strategy 3: Reform and enhance R&D for ICT development.

Goals

1. The Government should ensure that the public and private sectors together invest in ICT research with the aggregate amount equal or greater than 3 percent of the total ICT industry value.
2. The Government should provide a large software development project[1] that requires at least 100 man-years of work, and this project must include research and development activities with the amount of not less than 5,000 million baht by 2006.
3. By 2004, at least 80 percent of PC value and at least 50 percent of software value consumed within the country should be locally developed.
4. By 2004, at least 70 percent of the Thai software developers should be working in network computing[2] and/or Web services.

[1] It does not include services.

[2] This refers to new software technology, such as Java and NET, used for building software systems that operate on network.

Strategy 4: Develop human resources to improve national competitiveness.

Goals

1. By 2006, at least 70 percent of the workforce should have an access to ICT and 40 percent should have an access to the Internet.
2. By 2006, at least 90 percent of all students should be ICT literate.
3. By 2006, the number of knowledge-workers should be increased by at least 150,000 persons.

Strategy 5: Enhance entrepreneurial spirits and leadership to strengthen national competitiveness.

Goals

1. By 2006, the proportion of employment within ICT-based industries should constitute at least 600,000 persons (or 1 percent of total national workforce).
2. Market value contributed by e-commerce should be increasing at a minimum rate of 20 percent annually.
3. By 2006, the economic contribution of ICT-based industries should be at least 10 percent of the total national economy.

Strategy 6: Promote the utilization of ICT in SMEs.

Goals

1. By 2006, at least 100,000 SMEs should make use of ICT for back office activities.
2. By 2006, 40 percent of the SMEs should make use of ICT for their core business activities.
3. The number of entrepreneurs within supply chain domain should be increasing at the rate of 10 percent annually.

Strategy 7: Stimulate the utilization of ICT for the purpose of public administration and services.

Goals

1. By 2006, all government agencies within a ministry should be able to exchange information and communicate electronically despite their location in the country.
2. By 2006, through electronic means, every ministry should be able to integrate all relevant data from various locations throughout the country.
3. By 2006, at least 60 percent of government agencies should have complete ICT management.
4. By 2006, at least 90 percent of public service transactions should be offered online also.
5. By 2006, at least 50 percent of government agencies should be able to provide electronic services for State fee payment to all provinces.
6. By 2006, ministries should exchange information to provide at least 100 public services online (e-citizen).
7. By 2006, at least 100,000 million baht of government procurements should be done online (e-procurement).
8. ICT security policies and regulations must be put in place.
9. By 2006, basic software applications should be available for government agencies.

Among these seven strategies, three have been put into the national top priority agendas: ICT industry development (software industry in particular), human capital development and ICT utilization within the public sector. One can clearly see that these three strategies are highly related. For example, to strengthen the industry, quality human capital is needed. Likewise, ICT utilization in the public sector will result in a significant expansion of a local ICT market, which, in turn, will stimulate further industry development, so on and so forth. At present, many implementations have been conducted to support these three strategies. For example, the plan to set up the Software Industry Promotion Agency has been executed and this agency is expected to be instituted very soon. Furthermore, augmentation has been made to the service boundaries of the Visa Service Centre operated by the BOI to

accommodate all visa/work permit requests for IT knowledge workers (whether or not they are employed by BOI member organizations). After this new regulation is fully implemented, with a complete set of documents filed, IT knowledge worker's visa/work permit can possibly be granted within a few hours.

Within the past decade, there have been significant changes regarding ICT progress of Thailand. With a very strong leadership and enthusiasm from the top, together with the establishment of the ICT Ministry – the appointed ICT champion – there is no doubt that Thailand will further progress technologically, socially and economically in this digital era.

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