Component 5
Technology Infrastructure and Connectivity
Overview

The type and standard of physical and technological infrastructures and affordable connectivity available in the six countries vary. At one end of the spectrum is Singapore where there is 100 percent connectivity to all schools through a WAN while also offering broadband connection. Schools in Indonesia are connected in a citywide wireless WAN through an intercity backbone connection using fibre optic and satellite connection. Malaysia, under its Smart Schools Project, has connected 187 Smart Schools using both broadband and ISDN and is now about to expand this further.

Thailand and the Philippines make use of dial-up access. Thailand has connected 5,000 schools out of approximately 34,000 schools nationwide to its SchoolNet, with free Internet dial-up access through a cheap local telephone call. The Philippines has also established SchoolNet to connect 15 pilot schools under a dial-up Internet access used in a decentralized way.

Pelgrum (2001), in a worldwide survey of schools from 26 countries, found that the most frequently mentioned problem in integrating ICT in education is the insufficient number of computers. Williams, Coles, Wilson, Richardson and Tuson (2000) cited limited availability of ICT resources as a major obstacle to classroom management and organization of resources. Cheung (1997) observed that pupils tended to lose concentration when groups working on a computer are too big. Given a large student group and a teacher’s limited time for each lesson, there is not enough opportunity for each pupil to use the computer. Pelgrum (2001) also noted that insufficient peripherals and learning software is one of the ten major problems related to ICT integration in schools. When peripherals, such as earphones and microphones, and copies of learning software are insufficient, teachers have great difficulty in planning and conducting lessons even if there are enough computers (Cheung, 1997).

This component focuses on the following issues: (i) mobilizing support from telecommunications and ICT organisations and industries, (ii) choice and mode of deployment of technologies, (iii) connectivity options and alternatives, (iv) infrastructure that supports and delivers teaching and learning, (v) emerging technologies, (vi) donated computers, (vii) open source software, (viii) guidelines on information security, and (ix) integration of school management software with the learning management system (LMS).
Lessons learned

Based on the experiences of all six countries except Indonesia, the following are the lessons learned:

1. Mobilizing Support from Telecommunications and ICT Organisations and Industries
   - Tapping local telephone companies and ICT industries for support has promoted affordable Internet connectivity and computer hardware and software.

2. Choice and Mode of Deployment of Technologies
   - When deploying technologies to schools throughout a country, establishing a balance between equity and effectiveness is necessary.
   - Deploying ICT in different types of pilot schools or demonstration schools will generate lessons on how to increase ICT use at different school levels and cull best practices.

3. Connectivity Options/Alternatives
   - Use of satellite and Internet schemes has enabled some countries to reach marginalised areas or economically disadvantaged groups.
   - Working closely with Internet Service Providers (ISPs) helps in determining appropriate bandwidth connection in schools and homes.

4. Infrastructure to Support and Deliver Teaching and Learning
   - There is no perfect combination of online and offline resources to promote effective teaching and learning.
   - Digital libraries for schools may be introduced as infrastructure to support and deliver teaching and learning.

5. Emerging Technologies: Dealing with Rapid Development of Technologies
   - ICT pilot projects should not take more than three years to complete since the obsolescence rate of present-day technologies is increasing.
   - Mobile computing offers schools many opportunities that include overcoming constraints of space and giving flexibility in anytime-anywhere utilization of ICT in schools.
   - Leasing equipment from private companies can be one solution to the problem of rapidly increasing obsolescence rate of present-day technologies.

6. Donation of Computers
   - Vocational colleges can be tapped to provide maintenance service for computers donated to schools.
   - Donated computers that have exceeded their lifespan may be redeployed for other uses or may be offered to needy students in other schools or some government and charity organizations.

7. Open Source Software
   - Although open source software (Linux-SIS, locally-developed word processor and digital toolkit for developing web content) is encouraged in the schools, there are limitations that must be taken into account before schools decide to use open source software.

8. Guidelines on Information Security
   - Preparing and disseminating guidelines on ICT security help in dealing with information security problems in schools.

6. Integrating School Management Software with Learning Management System (LMS)
   - Maintaining the inter-operability of a common school management system while ensuring that decoupling is built into the system is a need expressed by most countries. There should be adequate in-house training to help school staff and students in using LMS and in coping with the transition from manual to automated processes.
Synthesis of Experiences

Issue 1
Mobilizing Support from Telecommunications and ICT Organisations and Industries

SchoolNets in various countries have taken initiatives to obtain cost reductions for computer equipment and software and applications from private companies.

a. Indonesia: PT Telkom, the main telecommunications company in Indonesia, signed an MOU with several schools in East Java. Under the MOU, PT Telkom will charge schools a special rate for using telephone infrastructure. Another telecommunications company that has provided affordable rates is PT Indosat. PT Indosat actively participates in WAN Kota programmes initiated by the Ministry of National Education.

b. Malaysia: Telekom Malaysia, the country’s main telecommunications company, has proposed a special rate for telecommunications services to schools and the Ministry of Education (MOE). Another telecommunications company, Maxis, is collaborating with Telekom Malaysia to provide Internet access and telephones to 220 remote schools and their surrounding communities in Sabah and Sarawak.

The consortium that developed the Smart School Integrated Solution is helping the MOE to tap the resources of local and international hardware, software and applications companies in order to obtain cost reductions for the schools. Microsoft offers a special price for schools and other educational institutions. Currently, to address the high costs of long distance telephone calls, calls are made via a 1-300-xxx number and are levied local call charges. Calls can be made to this number from anywhere in Malaysia.

c. Philippines: Leading telecommunications companies, including Globe/IslaCom, PLDT, Bayantel, and Digitel, have provided over 100 public high schools with free telephone service and Internet access for one year and are extending a 50% discount for succeeding years to these schools. Numerous private companies, e.g., Intel, Microsoft, Sun Microsystems, Lucent Technologies, Cisco, etc., have also supported school networking through hardware/software donations and training grants.

d. Thailand: IT initiatives with NECTEC, TOT and CAT have brought benefits to the SchoolNet project, resulting in free Internet dial-up access from anywhere in Thailand at the cost of a local telephone, that is, three Baht. Compaq, Intel and Powell Computer have contributed as well. Powell Computer donated Pentium computers to 32 schools in rural areas. Microsoft donated 50 sets of Windows 95 and utilities to speed up schools’ activities on the Net.
e. **Singapore**: To reach households in the low-income bracket, six hardware and software providers and one ISP donated computers and other software. These households were provided with used PCs bundled with free Internet access and basic training.

**Issue 2**

*Choice and Mode of Deployment of Technologies*

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**Lesson Learned 1**

> When deploying technologies to schools throughout a country, establishing a balance between equity and effectiveness is necessary

ICT in education programmes must address the ever widening digital divide, taking into account geographical locations, socio-economic status, gender issues, ethnicity, and so on. These programmes must also recognize that while a tremendous amount of resources is needed, the levels of acceptance and utilization of computers and the Internet will vary from community to community.

a. **Philippines**: Because of scarce resources,DepEd has had to choose whether to emphasize breadth (i.e., to provide facilities to as many schools as possible), or to emphasize depth (i.e., to provide a more comprehensive ICT package but to fewer schools). Political exigencies have tipped the balance in favour of nationwide roll-outs rather than more focused pilots. In some cases, such as the “PCs for Public Schools” programme, donors restrict the use of funds to purchase hardware and peripherals only. At the same time, some NGOs, corporations, and corporate foundations simply parachute computers to the schools and do not follow-up whether the ICT facilities that they help to build are instructionally effective and sustainable.

Predictably, the highest PC penetration rate in schools is in Metro Manila at 87%. A distant second and third are the highly industrialized regions of Central Luzon (25%) and Southern Luzon (22%). In the 13 remaining regions of the country, only 16% of the schools (or less) have computers. PC penetration rates of less than 5% are found in the poorest regions - Eastern Visayas (4.9%), Western Mindanao (3.4%), and the Autonomous Region of Muslim Mindanao (3.2%).
Deploying ICT in different types of pilot schools or demonstration schools will generate lessons on how to increase ICT use at different school levels and cull best practices.

**Issue 3**

**Connectivity Options/Alternatives**

- **Malaysia:** Different types of schools were to be represented in the original Smart School Implementation Plan. The list was revised in 1999 to involve mostly existing secondary schools. Only five primary schools were chosen and these were schools that had yet to be constructed. By the end of the pilot project, only 83 secondary schools (including two newly constructed schools) and four primary schools (all newly constructed schools) were included. The other three schools (one primary and two secondary, all newly constructed) did not meet the contractual deadline for inclusion. Each of the fifteen States was allocated at least two pilot schools. States with larger student populations were allocated more pilot schools. The list included urban, semi-urban and rural schools.

- **Thailand:** In the next phase of operation of the SchoolNet, the responsibility to expand the connection to 34,000 schools in accordance with the National ICT Policy will be transferred to the MOE. SchoolNet will be merged with the newly established national network, EdNet. The decentralization of the ICT infrastructure through EdNet started in 2003, to connect all schools at all levels and educational institutions and enable them to integrate ICT for educational purposes. This will be accomplished by 2005. As part of the One District One-Dream School Project, there will be at least one school in each district that is equipped with one computer laboratory to facilitate ICT use in the curriculum. For schools in remote areas that lack electricity or telecommunications infrastructure, distance education through satellite broadcasting will be utilized. These technologies will help to ensure equal service to all schools and educational institutions.

Use of satellite and Internet schemes has enabled some countries to reach marginalised areas or economically disadvantaged groups.

- **Malaysia:** Some pilot schools were given satellite and wireless connection to the Smart School Network because of problems with landlines in their areas.

- **Indonesia:** Through WAN Kota, Indonesia has managed to connect its schools in a citywide wireless WAN with an intercity backbone connection using fibre optic and satellite connection.

- **Singapore:** To bridge the gap between those who are more economically well-off and those who are not, the Government is committing $S$25
Working closely with Internet Service Providers (ISPs) helps in determining appropriate bandwidth connection in schools and homes

This collaboration may be in the form of subsidized subscriptions or discounted rates based on a long term contract. Although there are clear educational benefits to using broadband Internet access, the proportion of online learning activities that the school has designed and organized for the students must be taken into account. Otherwise, schools may be operating at excess capacity and students and teachers may end up using this connection for personal entertainment purposes.

a. Indonesia: ISP of Indonesia has initiated a programme known as Sekolah2000. The goal of the programme is to make 2000 school in Indonesia connected to the Internet in the year of 2000. By the end of 2000, the project had connected 1,180 schools which translating into half a million new Internet users from high schools.

b. Malaysia: Each pilot school in the Smart School Network was provided its own Local Area Network through a structured cabling system. The vertical cabling used fibre optics and UTP, while the horizontal cabling used UTP. All 87 pilot schools, the Ministry’s Data Centre and Help Desk were connected to a Smart School Virtual Private Network provided by the Corporate Information Superhighway or COINS. Every computer in the Smart School System is Internet-enabled and connected to the Ministry’s Virtual Private Network. The bandwidths chosen for the different models of technology were based on financial constraints at the time. During the pilot project, it was evident that a bandwidth of 128/64 kbps for Level B and Level B+ pilot schools was insufficient to support the Smart School Applications Software and communications requirements.

c. Philippines: Internet access in the basic education system is limited, with only 14% percent of schools nationwide having Internet access. Of public secondary schools with Internet access, only 9% use the Internet for instructional purposes. Furthermore, 44.5% of public secondary schools that use the Internet for instructional purposes only have one computer that can access the Internet. Online time is also fairly limited. A little over half of the schools access the Internet at an average of less than an hour per day. Bandwidth limitations are also a factor. All but one of the schools has a dial-up connection with a maximum speed of 56.6kbps (SEAMEO-INNOTECH, 2002). This is not surprising since dial-up access is still the cheapest available. What is gained in affordability, however, is often lost in terms of speed and stability. Connection speed invariably decreases during peak hours - usually towards noon and in the early afternoon, especially when ISP use is near to or at full subscription. The number of computers in a school that are simultaneously accessing the Internet through one line slows down speed. Schools have also experienced difficulty in dialing up the ISP and/or being frequently disconnected especially during peak hours.

d. Singapore: Although all schools are linked through a WAN, which is in turn connected to a high-speed backbone of Singapore ONE, student take-up rate of broadband subscription for their home varies; it is high for some schools (more than 75%) and low for others. In interviews...
There is no perfect combination of online and offline resources to promote effective teaching and learning

Any type of combination depends on the infrastructure of individual schools. In many countries, broadband connection is still very limited. A combination of online and offline mode seems most appropriate and flexible. The production of online resources should be repackaged in order to accommodate an offline mode.

a. Thailand: As of August 2003, 70% of primary schools have no telephone lines, 4% no electricity, and 79% no computers for teaching and learning. All secondary level schools have computers at a ratio of 1 computer for every 54 students, 71% have Internet connection, and 17% have no telephone lines. The student population in these schools ranges from 300 to 500 to over 3,000 students. Considering the availability of ICT infrastructure and the size of these schools, ICT use for teaching and learning can be described as follows:

- Schools with insufficient infrastructure, normally use stand alone computers and printers and general office software bundled with word processors, spreadsheets and so on. Presentation or graphic software is used in many subject areas. If Internet dial-up connection is available, this is used for information search. Satellite TV is used in some remote areas or as a supplemental tool to ease the shortage of ICT infrastructure.

- Schools with average infrastructure availability have at least one computer laboratory that is connected to a LAN and Internet and can provide students an opportunity to use the Internet in the classroom for information search, collaborative projects, product creation, and on-line activities. Satellite Internet-link is used to provide such opportunities to schools without telephone lines.

- Schools with sufficient infrastructure are able to mix the modes of ICT use. On-line or off-line can be used to support the teaching and learning process, making it more flexible and extendable beyond the classrooms. Parents and communities can be involved in the student learning process.
While digital libraries are currently possible in more advanced countries, like Singapore and Korea, other countries should nevertheless plan for these in the future. Recognizing that the school library is a core facility for teaching and learning, UNESCO in 1998, along with the International Federation of Library Associations and Institutions (IFLA), adopted the UNESCO/IFLA School Library Manifesto, which urges governments to formulate legislation and policies on school libraries, covering their principles, goals, staffing needs, budgets, operations and management.

a. South Korea: Under the Government’s Comprehensive Promotion Plan for ICT Use in Libraries, launched in March 2000, model digital data rooms were set up in school libraries with full-time librarians. In 2001, 96 elementary and secondary schools were selected for the installation of digital data rooms, followed by 123 schools in 2002, of which 119 were city or provincial schools and four were national schools. Each school received funds amounting to 42 million Won (US$35,500). In city or provincial schools, half of the funds were generated from the Information Society Promotion Fund and the other half from the local government. For national schools, the Information Society Promotion Fund provided the full amount. Of the total budget of 800 million Won (US$676,000), half was generated from the National Treasury for the development of software, and the other half from the local government for the purchase of servers and other equipment. Based on applications submitted by cities or provincial Offices of Education, KERIS selected the most appropriate Office of Education as site of the Digital Data Support Centre. In 2003 the digital data rooms will be further expanded following a review of the model rooms.

b. Thailand: Digital Library, a SchoolNet Content Development project, was started in 1998 to encourage ICT use by teachers who are not competent in English. The project was carried out by Kasersart University in conjunction with IPST. The Digital Library has become a repository of Thai-based teaching/learning lessons contributed by a university and science centre-based team and by teachers and students. A website was opened in the Thai language for secondary school students in seven major academic subjects, namely, computer science, mathematics, physics, chemistry, biology, engineering and environment. The software in use, Digital Library Tool Kit, allows teachers, especially those with no knowledge of HTML, to develop Net-based lessons for students. The Digital Library offers opportunities to participate in international collaborative projects through the Global Learning and Observations to Benefit the Environment (GLOBE) Programme and the ThinkQuest Project. Apart from providing content and information resources on the web, the Digital Library also offers Internet and web page development training courses, seminars and other activities, for teachers and students from participating schools.
Emerging Technologies: Dealing with Rapid Development of Technologies

**Lesson Learned 1**

*ICT pilot projects should not take more than three years to complete since the obsolescence rate of present-day technologies is increasing*

*a. Malaysia:* When the Smart School Pilot Project Agreement was being finalized in 1999, the technologies selected were not all cutting-edge technologies, but they were deemed appropriate for the job. Specifications for ICT and non-ICT equipment, courseware, systems software, and the network were up-to-date at the time that the Agreement was formalized. By the time the pilot project ended in 2002, the specifications were no longer sufficient or up-to-date. For instance, the Microsoft NT platform used for the development of the SSMS had long been replaced by newer platforms.

**Lesson Learned 2**

*Mobile computing offers schools many opportunities that include overcoming constraints of space and giving flexibility in anytime-anywhere utilization of ICT in schools*

*b. Singapore:* Using notebook computers in classrooms, with size and portability as advantages, is an option that some schools have taken up. By using notebook computers, there is greater flexibility in arranging students for group learning and the problem of small space is resolved. Also, higher utilization of computers is encouraged.

With the emergence of new technologies and small devices, such as hand-held computers and mobile phones, the potential of these devices as teaching and learning tools (as well as for classroom management) should be explored.

*a. Malaysia:* In 2001, the Ministry initiated a pilot project on the use of the electronic book or e-book to find out how this device could be used to improve teaching and learning in the classroom. The Ministry was also interested in studying the e-book to replace conventional textbooks and thus resolve the problem of heavy school bags. The pilot project was conducted in 35 schools over a period of five months. The company involved in the pilot project supplied 2491 e-books to the schools. More than 400 teachers and about 2000 students were involved in the project. Initial findings indicated that the device improved computer and technology knowledge, as well as engaged students in reading and learning.
a. **Thailand**: Technology changes very fast and schools have to cope with emerging technologies. Outdated computers cannot be discarded and replaced with new ones, unless they have been used for a certain period of time, usually five years, according to the Government’s current procedures concerning hardware procurement. To cope with the rapid development of technologies, some schools have resorted to leasing ICT equipment from private companies.

The burden of maintenance is a problem associated with donated computers. Old computers that have exceeded their lifespan will entail maintenance and support expenses. These must be taken into account in the cost-benefit analysis so that users can make informed decisions between new and used computers.

a. **Thailand**: Second-hand computers or outdated ones that are in good conditions can still benefit some schools despite their limitations in running some application software. MOE collaborates with the private sector and the MICT to solicit computer donations. However, some schools have no technical staff to repair or change parts when these donated computers are out of order. The Ministry has requested vocational colleges to provide maintenance service for schools near them.
Donated computers that have exceeded their lifespan may be redeployed for other uses or may be offered to needy students in other schools or some government and charity organizations.

The redeployment of old computers to needy students and households should be handled as a collaboration between schools, MOE, and other government agencies/organizations or self-help groups.

a. **Singapore**: The PC Re-Use Scheme, managed by IDA and initiated in November 1999, provided for the donation by the MOE of some 10,000 used PCs over a five-year period, to underprivileged families. Recipients must be Singapore Citizens or Permanent Residents from a household with a gross income not exceeding $2000 per month. A member of the household should have attended the National IT Literacy Programme. The recipients pay a nominal fee for the refurbished PCs. The first batch of PCs went to families identified by the Singapore Indian Development Association (SINDA), the Council for the Development of the Singapore Muslim Community (MENDAKI) and the Northeast Community Development Council, in March 2000.

The MOE has been one of the largest donors of computers to the scheme, replacing PCs in schools every three to five years, averaging annually up to 12,000 PCs since 2002.

**Issue 7**

**Open Source Software**

Although open source software (Linux-SIS, locally-developed word processor and digital toolkit for developing web content) is encouraged in the schools, there are limitations that must be taken into account before schools decide to use open source software.

a. **Thailand**: School use of software is usually limited to those bundled with the purchased computers, e.g. Windows operating system, MS office software, web browsers. Other software includes downloaded freeware or shareware or those that are illegally copied. The Government, particularly the Intellectual Property Department, encourages the use of legally obtained software and has requested software producers to reduce their price. Open source is preferred as this is better in terms of copyright-free problem. A recent government project to develop local application software for LINUX responds to the lack of Thai language software.

The Linux SIS (School Internet Server) was developed by NECTEC in 1996 to solve the problem of licensing the operating system for
servers. NECTEC later developed the Web-SIS in Thai Language, enabling teachers to manage the Internet server by using the web interface instead of the command line. This helped the teachers to overcome the difficulty of managing the network as well as the language barrier.

**Issue 8**

**Guidelines on Information Security**

**Preparing and disseminating guidelines on ICT security help in dealing with information security problems in schools**

There should be adequate on-site and remote monitoring of guidelines to prevent breaches of security.

- **Malaysia**: The Smart School Integrated Solution produced a set of school-level ICT policies and procedures, which were reviewed by the pilot project team to ensure that they were in line with existing Ministry rules and regulations, and later submitted to the Malaysian Administrative Modernization and Management Planning Unit (MAMPU) in the Prime Minister’s Office, the central agency responsible for all matters relating to ICT use in the country. The security policies covered authentication and passwords, backup procedures, installation of firewalls, and use of licensed software.

  The Data Center and Help Desk personnel of the Smart School Development Team deal with problems of hacking and virus attacks on the Smart School System. At present, the team uses the Norton Antivirus Software for this purpose.

  The Smart School ICT Policies and Procedures, updated twice since its introduction in 2000, provide guidelines on how to deal with hacking and virus attacks.

- **Thailand**: Currently available anti-virus or filter software is used to solve the problem of computer viruses and hacking. However, most anti-virus software that run on servers are quite expensive and unaffordable for many schools where the cost of license per annum is relatively high. New computer viruses that attack users around the world also affect users in Thailand. Schools usually employ preventive measures that are economically affordable.

  Guidelines on information security are found in most websites of universities, and agencies, such as NECTEC. The websites feature guidelines to prevent security risks, warnings of new viruses and their file formats, and first aid to fix the problem.
Integrating of School Management Software with LMS

Lesson Learned 1

Maintaining the inter-operability of a common school management system while ensuring that decoupling is built into the system is a need expressed by most countries.

A major complaint by school teachers is the amount of time required to perform routine non-teaching tasks. There is a need to optimize the potential of ICT, automate administrative processes, and provide linkages with the teaching and learning processes, assessment and external MOE databases.

a. Malaysia: The integrated management software, SSMS, covered nine areas of school management: Financial, Student Affairs, Educational Resources, External Resources, Human Resources, Facilities, School Governance, Security, and Technology. In addition to supporting the management functions of the Smart School, the SSMS also integrated the following systems: Teaching and Learning Materials, Assessment, IT Security Management, Network and System Management, User Support and Help Desk. The SSMS helped to integrate the different functions by acting as a common user front-end for access to all Smart School applications, consolidating database information across multiple applications, allowing access between certain applications and other databases and applications, and allowing access to existing databases within various divisions in the MOE.

The MOE wanted the following features for the SSMS: portability, flexibility, inter-operability, scalability, usability, and manageability. However, due to technological and financial constraints in 1999, the Ministry compromised on all the features. This resulted in an integrated SSMS with functionalities that could not be easily decoupled.

Lesson Learned 2

Maintaining the inter-operability of a common school management system while ensuring that decoupling is built into the system is a need expressed by most countries.

a. Malaysia: The SSMS was not optimally used by most of the pilot schools, according to findings from monitoring exercises carried out in the pilot schools by the MOE. The common reasons given were that the system was not user-friendly, hung easily, and did not simplify the routine tasks of teachers and other school staff members. In most cases, the Ministry discovered that the schools had not completed the data entry necessary to prime the system, and that the staff and students were not using the system correctly. However, pilot schools with complete data entry and adequate in-house training found that the system supported the teaching and learning processes by managing resources and processes more efficiently and effectively.
ICT LESSONS LEARNED

Integrating ICTs into Education