Annexure 9 - The Due Diligence Report in Respect of the Feasibility Study for an e-Education Initiative in South Africa

Contents

Project Terms, Definitions and Abbreviations

Terms and Definitions	Meaning
Adaptation level	The educator is able to use ICT to develop and/or evaluate school or FET College ICT Development Plans. He/she stimulates ICT use in his/her environment, and is able to reflect critically on how ICT changes the leadership and teaching and learning styles and to use ICT systems for management, administration, teaching, and learning.
Administrators	People at any location who are concerned with the administrative activities of the Institution. Educators are included, for the purpose of this definition, to the extent that they provide information to administrative systems (for example, SASAMS) in an administrative office or staff room.
Applications	The term application is a shorter form of application programme. An application programme is a programme designed to perform a specific function.
Architecture framework	Architecture framework is more than just providing ICT infrastructure to schools and FET Colleges, but rather takes a holistic view in terms of what services should be provided, how these services are provided, what the underlying technology is on which these services are built and interact, how the services should be accessed by the various role players (administrators and managers, educators, and learners) and what standards should govern the implementation of each of these components (services, technology, and role players).
Backbone	The WAN comprises the Backbone and Last Miles. Each entity is connected by a 'Last Mile' to the Backbone which is that part of a WAN that is shared by all of the entities.
Bandwidth	The amount of data that can be carried from one point to another in a given time (usually a second).
Basic Readiness	Means the basic conditions that need to be met at each school or FET College site before rollout of ICT infrastructure can commence at a site The basic conditions cover items such as: • Appropriate documentation and policies on standard operating procedures; • Existing systems, including SASAMS; • Support structures and manuals; • Training requirements; • Human resource implementation capacity; • Civil infrastructure (such as school buildings, electricity, water, sanitation, road access); • Physical security for ICT equipment; • 'Last-mile' access; and • Communication and change management.
Building Block or Technical Building Blocks	An ICT or physical infrastructure component that is part of an Architecture Layer.
Building security	Building security is directed at the control of movement of persons and moveable assets in and out of the building(s) and within the buildings(s) on the institution's site.
Computer	Either a desktop computer or a laptop.

Terms and Definitions	Meaning
Connectivity	The infrastructure and services required to allow end-user devices to successfully communicate with the ICT infrastructure and therefore allow the role players to access the various applications and services to which they require access.
Creative Commons licence	Creative Commons licences allow authors to retain certain rights while granting other rights to users (particularly the right to make copies of content produced). See www.creativecommons.org for details of specific licences.
Delivery Option	Procurement and/or implementation method of services and products aimed at accomplishing the rollout of an identified service delivery option from the Options Analysis as determined by the Institution.
Department	The national Department of Education or provincial Department(s) of Education, as the context may require.
Dependencies	Items on which success of the e-Education Initiative is contingent. Dependencies help to delineate clearly which aspects of achieving the intended Impact Statement fall within the e-Education Initiative and which will be the responsibility of other parts of the Institution.
Desktop/ Desktop computer	A personal computer that is designed to fit conveniently on top of a typical office desk.
Educational content	Content refers to the teaching and learning materials that support delivery and interpretation of the curriculum. 'Educational content' denotes all materials that are designed or suitable to support teaching and learning directly.
Educational Technology Plan	All schools have developed, implemented, and are continually refining rolling three-year ICT integration plans. A structure for this plan has been agreed which is representative of different interests and includes at least the following elements: • A long-term vision for use of ICT in the school; • Codes of conduct for ICT usage by learners, educators, school management and administration, and the wider community; • Curriculum policies outlining how the school intends to use ICT to support teaching across grades and learning areas/subjects; • A detailed assessment of ICT requirements; • Timetables outlining how the ICT resource will be integrated into the school day, and what levels of access will be made available to which grades of learners; • Clear policies on extended afternoon, weekend, and school holiday use of ICT, accompanied by plans to provide incentives to teachers to enable this extended use; • Policies on community use of ICT; • School strategies to acquire further ICT as appropriate; • Professional development strategies on use and integration of ICT in educational, management, and administrative tasks; • School strategies to cover operating costs of ICT; • Defined roles for school ICT coordinators and support staff and their backups; • Guidelines on ICT application and educational content acquisition; • Strategies for ICT support and maintenance; • Strategy for ICT renewal; and • Strategies for monitoring and evaluation of implementation of the

Terms and Definitions	Meaning
	e-Education Initiative.
Educator	The term educator is being used, as it is defined in government policy, to refer to the full spectrum of employees engaged in schooling and the FET College system. This is in line with the South African Council of Educators Act, 2000. In this Act, an educator is defined as any person appointed: in terms of the Employment of Educators Act, 1998 (Act No.760f 1998); in terms of the South African Schools Act, 1996 (Act No. 84 of 1996); in an independent school; in terms of the Further Education and Training Act, 1998 (Act No. 98 of 1998); at a further education and training institution; at an adult learning centre; and 'who teaches, educates or trains other persons or who provides professional educational services, including professional therapy and educational psychological services, at an institution.
e-Education (as defined in the White Paper)	The concept of e-Education revolves around the use of ICT to accelerate the achievement of national education goals. It is about connecting learners and educators to each other and to professional support services, and providing platforms for learning. It will connect learners and educators to better information, ideas, and one another via effective combinations of pedagogy and technology in support of educational reform. It supports larger systematic, pedagogical, curricular, and assessment reforms that will facilitate improved education and improved use of educational resources such as ICT.
e-Education Initiative	The objective of the Institution is to implement e-Education in Public Schools and FET Colleges. The term Initiative is being used when referring to the Feasibility study as a project is finite in time and investment. Initiative is used to denote that the intentions of the Institution are ongoing and continuously changing to be as current as possible.
E-Learning	Learning that is facilitated by the use of digital tools and content.
Email	A process of sending text messages in electronic form.
End-user computing	A group of approaches to computing that aim at better integrating end users into the computing environment or that attempt to realize the potential for high-end computing to perform in a trustworthy manner in problem-solving of the highest order.
e-Readiness	Before implementation of school or FET College Educational ICT Development Plans can commence, certain conditions, as set out in Section 9 of the Options Analysis, need to be met at each school or FET College site.
Feasibility Study	The national Department of Education is conducting a feasibility study in terms of Treasury Regulation 16 (dealing with PPPs) to the PFMA in respect of the e-Education Initiative. The purpose of the feasibility study is to determine whether the e-Education Initiative is in the best interest of the Institution.

Terms and Definitions	Meaning
FET College	Means a public further education and training (FET) institution that is established, declared, or registered under the Further Education and Training Act, number 16 of 2006, but does not include: a) A school offering further education and training programmes under the South African Schools Act; or b) A college under the authority of a government department other than the Department of Education; or c) A private further and training institution (meaning the Member of Executive Council does not provide funds to the institution appropriated by the provincial legislature). It includes all learning and training programmes leading to qualifications at levels 2 to 4 of the National Qualifications Framework or such further education and training levels determined by SAQA and contemplated in the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), which levels are above general education but below higher education.
ICT Laboratory (ICT Lab)	A learning space/ classroom within a school specifically adapted for the installation of a large number of computers (between 25 to 45), also referred to as a computer room.
Impact	The extent to which investment in the e-Education Initiative will affect various systems within the Institution.
Impact Statement	A statement, in broad terms, of: a) A 'primary' impact that is expected to arise from investment in e-Education in respect of: (i) enhancing its logistics and operations; (ii) building educators' capacity to teach effectively; and (iii) providing all learners access to quality education; or b) A 'secondary' or ancillary impact that is expected to flow as an indirect consequence of investment in e-Education.
Information and Communication Technologies (ICT) (as defined in the White Paper)	ICT represents the union of information technology and communication technology. ICT is the combination of hardware, software, and means of communication that brings people together and enables processing, management, and exchange of data, information, and knowledge in order to expand the range of human capabilities.
Information Technology (IT) (as defined in the White Paper)	The electronic display, processing, and storage of information, but not necessarily the transmission of the information. IT carries strong historical associations with enterprise data processing and centralized computer services.
Institution	Collectively, the national Department of Education and the nine provincial Departments of Education.
Internet	A worldwide, publicly accessible series of interconnected computer networks.
Laptop	An end-user computing device that is designed to be easily transportable and usable in any location. Otherwise known as a 'notebook'.
Last mile	Connectivity options that may be used to connect each school or FET College to the nearest WAN Backbone connection point.

Terms and Definitions	Meaning
Local Area Network (LAN)	Comprised of the following components: • Routers/Switches, including one, some or all of: – For wired networks, Ethernet Cat 5; – For wireless networks, 802.11b, g or n; and – For power line communication (PLC) networks. • Network server(s). These computing devices provide facilities that are shared by authorized users. Servers may include mail servers, database servers, application servers, and the like.
Multifunctional devices	Devices that can be attached to a PC or to a network that can perform a range of functions, for example, faxing, printing, scanning, and copying. Also known as an 'all-in-one'.
Multimedia devices	Devices that can capture or output various media in combination, for example, sound and video.
Needs Analysis	The first stage of the Feasibility Study, which clearly argues the case for investing in the e-Education Initiative to assist the Institution to deliver its core services and meet its needs.
Network	An interconnected system of computers.
Network servers	A server that is designed and/or configured to monitor and control the flows of data through a network.
Norms and Standards	Guidelines typically associated with current and prevailing policy and legislation within the applicable environment.
Open source software	Programmes whose licences give users the freedom to run the programme for any purpose, to study and modify the programme, and to redistribute copies of either the original or modified programme (without having to pay royalties to previous developers).
Operating systems	An operating system is a programme. The programme, after being initially loaded into the computer, manages all the tasks and resources on a computer.
Option(s) or model(s)	A range of possible service delivery solutions/models for meeting the identified Outputs for the e-Education Initiative.
Options Analysis	The second stage of the Feasibility Study, setting out the range of possible options for delivering the required Outputs (as defined in the Needs Analysis) in respect of the e-Education Initiative, allowing the Institution to weigh up various options and make a choice.
Output	The specific, direct achievements or consequences expected to result from making judicious investments in the e-Education Initiative.
Peripherals	Any computer device that is not part of the essential computer.
Personal computer or PC	A personal computer may be a home computer, or may be found in an office, often connected to a LAN. The distinguishing characteristic is that the computer is used only (or mostly) by one person at a time, in a very interactive fashion, with no significant delay between an operator action and response by the computer. This is opposite from the batch processing or time-sharing models which allowed large expensive systems to be used by many people, usually at the same time.

Terms and Definitions	Meaning
Pillar	Any one of the six identified areas in which the e-Education Initiative will target investment, outlined below: c) Infrastructure – establish an ICT presence in public schools and FET Colleges. d) Network connectivity – institutions are connected, have access to the internet, and communicate electronically. e) Professional development – build teachers' and managers' leadership, confidence, and competence in use of ICT. f) Curriculum integration – institutions are using education content of high quality. g) Research, monitoring, and evaluation. h) Human resource systems – build an education and training system to support the integration of ICT in teaching and learning.
Private-Public Partnership (PPP) standardization	The *'Standardized Public Private Partnership Provisions'* issued as National Treasury PPP Practice Note 1 of 2004, dated 11 March 2004.
Principal	Includes a school principal, an FET College campus manager, or a FET College principal.
Printing and Multi-purpose device(s)	Printing device(s) can be: slow, medium or high-speed; monochrome or colour; and inkjet or laser printers. Printers can be single- or multi-purpose devices. Multi-purpose devices can provide additional scanning, photocopying, and/or facsimile capabilities. Printers can be linked to single end-user computing devices or shared among multiple end-users over a network.
Project	The Institution is considering various models for implementing the Pillars of e-Education, amongst others a PPP model. The national Department of Education has appointed a Transaction Advisor to assist it in exploring the feasibility of procuring the required services and infrastructure by way of a PPP or alternative method.
Proprietary software	Computer software with restrictions on copying and modifying placed on it by the creator or distributor.
School	A public school means an institution which enrols learners, for education purposes, in one or more grades between grade zero and grade twelve, as defined in the Schools Act, number 84 of 1996, and where the Member of Executive Council provide funds appropriated for this purpose by the provincial legislature.
Secure Network	A network (whether a standalone network or a virtual network within the Internet), which is only accessible to Authorized Users.
Service Delivery Option(s)	The service delivery options set out the range of possible Options for delivering the required Outputs (as defined in the Needs Analysis). It should be noted that service delivery options do not include a decision about the best way to procure the preferred service delivery option(s).
Site	A public school or FET College or FET College campus, as the case may be.
Site security	This is concerned with control of the movement of persons and moveable assets across the perimeter boundary of the particular site.

Terms and Definitions	Meaning
Software	Various types of software can be anticipated: i) Operating system software for end-user computing device(s), networked servers, and so on. j) Network Management Software. This is software that is used to monitor, configure and manage the LAN, as well as access by the users of the LAN. k) Application software directly or indirectly providing functional capabilities to end-users, for example, generic office software (such as word-processing and spreadsheets); departmental administration systems such as SASAMS and learning management software (planning tools, examination support systems, browsers, and so on). Whilst not immediately required for the support of logistic and administration, future phases of ICT deployment in institutions will use other types of application software (for example, educational content management and learner tools). In some instances, this software will share the same ICT infrastructure as will be used for the support of enhanced logistics and operations. For this reason, deployment of ICT infrastructure must give consideration to such future requirements.
Software standardization	The process by which the full range of software options for operating systems, utilities, applications and services is rationalised with the objective of providing a limited number of options that are able to interoperate and provide the required functionality.
Thutong Portal	South Africa's education portal.
Transaction Advisor	The transaction advisory team consisting of the lead member, KPMG Services (Pty) Ltd, and its main subcontractors Ledwaba Mazwai Attorneys, Lendar Projects (Pty) Ltd, Neil Butcher & Associates, and Macabee Risk Solutions (Pty) Ltd. The role of the Transaction Advisor is to conduct a Feasibility Study, in accordance with Treasury Regulation 16 to the PFMA.
Transversal systems	A system that is used generally across an environment. South African government transversal systems (for example, the Basic Accounting System) are operated and supported by the State Information Technology Agency (SITA). Institutional transversal systems are those operated and supported by the Institution.
Treasury Regulations	The National Treasury Regulations published in Government Gazette No 23788 of March, 2005.
Virtual Private Network (VPNs)	A communications network tunnelled through another network, and dedicated for a specific network.
Wide Area Network (WAN)	General term referring to a large network spanning a country or around the world.
Wireless	Refers to the type of broadband connection where information is sent from and arrives at a computer through transmission towers.

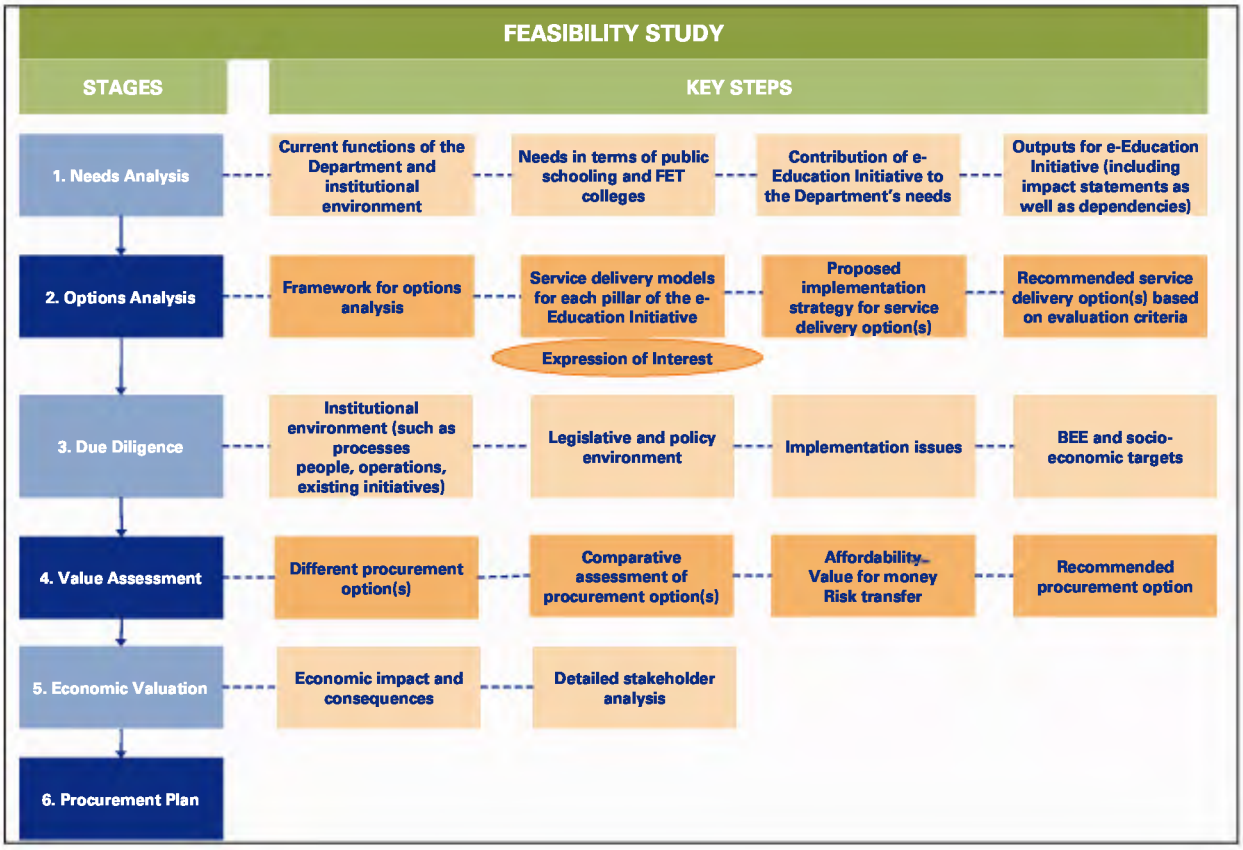
1 Introduction

1.1 Placing the Due Diligence Report

The national Department of Education is conducting a feasibility study in terms of Treasury Regulation 16 to the Public Finance Management Act, 1999 (PFMA) in respect of the e-Education Initiative. The purpose of the Feasibility Study is to determine whether the e-Education Initiative is in the best interest of the Institution. To this end, the Feasibility Study must:

1) Explain the strategic and operational benefits of the proposed e-Education Initiative for the Institution in terms of its strategic objectives and government policy;
2) Describe the specific terms of the e-Education Initiative in terms of the nature and extent of the Institutional functions, both legally and by nature, to be performed either by the Institution or by a private party;
3) Set out the legislative and regulatory framework applicable to the e-Education Initiative;
4) In relation to any financial commitment to be incurred, demonstrate the affordability of the e-Education Initiative for the Institution;
5) Set out the proposed allocation of financial, technical and operational risk between the Institution and a private party;
6) Demonstrate the anticipated value for money to be achieved; and
7) Explain the capacity of the Institution to procure, implement, manage, enforce, monitor and report on the e-Education Initiative.

The figure below shows the stages of the Feasibility Study:



Stage 1: Needs Analysis
A comprehensive Needs Analysis has been completed, which clearly argued the case for investing in the e-Education Initiative to assist the Institution to deliver its core services and meet its needs. The Needs Analysis defined a high-level set of Impact Statements which define in broad terms the impact that is expected from investment in e-Education. It also presented a set of Outputs for the proposed e-Education Initiative, which indicate what will be achieved through suitable investment in the e-Education Initiative, as well as Dependencies on which success of the e-Education Initiative is contingent. The Dependencies help to delineate clearly which aspects of achieving the intended Impact Statements fall within the e-Education Initiative and which will be the responsibility of other parts of the Institution.

Stage 2: Options Analysis
The Options Analysis set out the range of possible options for delivering the required Outputs (as defined in the Needs Analysis), allowing the Institution to weigh up service delivery options and make appropriate choice. It should be noted that, in the Options Analysis, the Institution did not make any decision about the best way to procure the preferred service delivery option(s). In the Options Analysis, the Institution, supported by the Transaction Advisor, identified and evaluated potential options for meeting the Institution's needs to deliver the e-Education Initiative. After consideration of various factors to be set out in the Due Diligence and Value Assessment stages, the Institution will make a decision about the best procurement option (Private Public Partnership – PPP – or alternative).

Stage 3: Due Diligence
The Due Diligence stage is an extension of the Options Analysis stage, and aims to uncover any issues in the preferred service delivery option(s) that may significantly impact on the proposed e-Education Initiative. This includes:

- A comprehensive legal Due Diligence of the preferred service delivery option(s) to ensure that all foreseeable legal requirements are met for development and implementation of the e-Education Initiative;
- A comprehensive technical and educational Due Diligence of the preferred service delivery option(s) to uncover any problems that may impact on the e-Education Initiative's affordability and value for money, or cause regulatory delays at implementation; and
- Identifying sectoral Broad-Based Black Economic Empowerment (BBBEE) conditions (for example, the extent to which Black Economic Empowerment (BEE) charters have been developed and implemented), black enterprise strength in the sector, and any factors that may constrain achievement of the e-Education Initiative's intended BEE outputs.

Stage 4: Value Assessment
This is a pivotal stage of the Feasibility Study. It enables the Institution to determine the best procurement choice for the e-Education Initiative. The three tests, in respect of procurement options, prescribed by Treasury Regulation 16 to the PFMA are:

- Affordability;
- Appropriate risk transfer to a private party; and
- Value for money.

Stage 5: Economic Valuation
The Economic Valuation will give a clear economic rationale for the e-Education Initiative, identify and quantify the economic consequences of all financial flows and other impacts on the e-Education Initiative, identify the opportunity cost of undertaking the e-Education Initiative by creating a no-investment scenario, and update the Stakeholder Analysis that has been done as part of the Needs Analysis.

Stage 6: Procurement plan
The Procurement Plan will demonstrate whether the Institution has the necessary capacity and budget to undertake procurement of the e-Education Initiative, as well as indicate the appropriate governance structure for procuring and implementing the e-Education Initiative.

1.2 Purpose of the Due Diligence Report

The purpose of the Due Diligence stage has been to uncover any issues in the preferred service delivery option(s) that may significantly influence the proposed e-Education Initiative. To accomplish this, the Due Diligence report has been structured to address key issues raised in feedback received on the Options Analysis report. Consequently, this Due Diligence report focuses on the following issues:

- A comprehensive legal due diligence of the preferred service delivery option(s) to ensure that all foreseeable legal requirements are met for the development and implementation of the e-Education Initiative (see section 1.3).
- A technical and educational due diligence of the preferred service delivery option(s) to uncover any problems that may impact on the e-Education Initiative's affordability and value for money, or cause regulatory delays at implementation. This focuses particularly on the following issues:
  - Review and validation of ICT options for the 'push' strategy of the e-Education Initiative, including a special focus on thin, fat and smart client networks;
  - Review of environmental considerations pertaining to the e-Education Initiatives, together with recommendations on how to handle these;
  - Comparison of FOSS and proprietary software options;
  - A model to project the number of ICT Laboratories required by schools to offer Computer Applications Technology (CAT) and/or Information Technology (IT) at FET level in schools, which were specifically requested to be included in the 'push' strategy of the e-Education Initiative by the Institution; and
  - Review of connectivity options and presentation of associated specifications (including specifications for aspects of the LAN).

1.3 Legal Due Diligence

The six pillars of the e-Education Initiative were separately considered in light of the existing legislative and regulatory instruments. The main questions dealt with in respect of each Pillar, where relevant, were:

- Which organ of state is entrusted with the institutional functions referred to in each pillar?
- Which organ of state is competent in law to implement a procurement process to procure a private party to undertake the service?

- Can the institutional functions referred to in each pillar of the e-Education Initiative be performed by a private party?
- Can an institution procure a private party to perform the institutional function on its behalf?

Other legal questions peculiar to each pillar or option were considered in the relevant pillar(s).

For the detailed legal Due Diligence, please refer to Annexure B of this report.

A comprehensive Due Diligence is important. If legal issues are not resolved during the Feasibility Study phase, this may result in significant delays at the negotiations stage of procurement. Also early legal, technical certainty directly affects costing.

1.4 Broad-Based Black Economic Empowerment (BBBEE) Conditions

The BBBEE conditions have been discussed in detail in the Options Analysis report, and so have not been repeated in this report.

2 ICT Infrastructure

2.1 Introduction

The Due Diligence phase consisted of further meetings with various representatives of the Institution and SITA, as well as provincial representatives from both SITA and the Institution, to obtain input on the validation of the feasibility of the various options. Further research was also performed in areas that required additional investigation and/or confirmation. The following sections detail those areas where further input and investigation were required, as well as conclusions reached.

2.2 Deploying ICT Infrastructure in Schools

Access to data, systems, and the network will adhere to necessary security norms, requirements, and protocols, which should comply with standards such as the Minimum Interoperability Standards (MIOS) for Information Systems in Government and Minimum Information Technology System Security Standards (MISS).

These standards not only specify requirements to ensure interoperability and seamless information flows across Government and the public sector, but also provide a benchmark that ensures protection of all sensitive information. To achieve the protection of information technology systems, data, applications and transactions/processes against unauthorized access, it requires protection of computer hardware, software, and data from accidental or deliberate unauthorized changes, destruction, disposal, removal and/or disclosure.

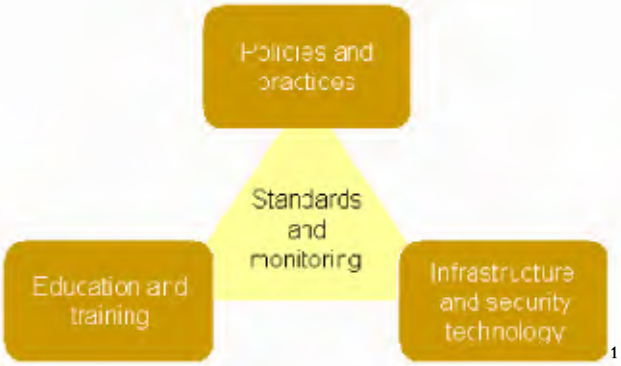
Not only do the MISS and MIOS provide the foundation for effective protection of the ICT environments but other standards such as ISO 17799/27002 provide additional guidance in relation to implementation of security standards which focus on specific concerns regarding security. These range from access controls to controls relating to the transfer of information across the network. These may be contextualized for the e-Education Initiative as follows:

- Access controls should be supported by appropriate policies which define the level and extent of security measures to be implemented.
- User access, whether for administrator, manager, educator, or learner, should be properly controlled to ensure that each user is uniquely identified within the system. The process used to assign permissions should restrict the level of access, as well as ensuring that appropriate authentication methods are applied to prevent unauthorized use of any user profile within the ICT environment, whether within the LAN or greater WAN.
- Access to the Internet should be controlled, especially for learners, by blocking and filtering undesirable sites and content (for example, pornography).
- Access controls should also include measures taken to ensure that a specific system or data is only accessible to those who are authorized and required to have access to them. To this end, specific measures should be taken to ensure that sensitive information or systems are isolated to enable better control and prevention of unauthorized access.
- Appropriate network controls should be implemented to ensure that access may not be obtained by unauthorized individuals who may use these actions for malicious or any other intent.

- Security features required to protect the ICT environment should be implemented within the network services, whether these services are provided internally or by an outside supplier.
- Data or information which is passed over public networks should be protected against disclosure and/or modification by unauthorized parties.
- Information which is made available on a publicly available system should be protected to prevent unauthorized modification and ensure that the integrity of the information is maintained.

It should be noted that no standard or security technology (including passwords, firewalls, network intrusion detection systems, security tokens, encryption, and so on) can provide assurance that information or identities are protected on its own. It is the carefully balanced functioning of an information security management process, with commitment and involvement from all parties involved and regular monitoring of the process, that provide the assurance.

The following model serves to illustrate this:



[1]

The requirements of the MIOS and MISS were incorporated in the ICT infrastructure and connectivity solution specifications, however, the effectiveness thereof will depend on development and implementation of policies and standards, as well as education of users.

2.3 Validation of Specific Options Proposed in the Option Analysis

During the Option Analysis, options were proposed for implementation of ICT infrastructure for administrators and managers, as well as educators and learners. During the Due Diligence phase, the recommended options were assessed to determine whether they are, in fact, viable when considering the current and long-term requirements of the e-Education Initiative.

Based on input from other role players and research conducted in regard to the options proposed, no further information or factors were identified that invalidate, or require changes to, the recommendations made in the Options Analysis. However, the categorization of schools was changed as a result, and accordingly the recommendations for administrators and managers were updated, as per the table below:

[1] BECTA – Safeguarding Children in a digital world

Table 1 ICT models for management and administration

School	Model	Justification	Computer Infrastructure	
			Principals	Administrators and Managers
Multigrade (<50 learners)	Shared, non-networked end-user devices with printing services	This option would apply to very small schools where only one end-user device is warranted, such as a small farm school, or to a separate building in a larger school, where network services are not essential and the cost of providing networked access is not justified.	1 laptop and 1 printer (not shared)	(Not applicable to single-employee schools)
Multigrade (<51 to 100 learners)	Shared, non-networked end-user devices with printing services	This option would apply to very small schools where only one end-user device is warranted, such as a small farm school, or to a separate building in a larger school where network services are not essential and the cost of providing networked access is not justified.	1 laptop and 1 printer (not shared)	1 desktop computer and 1 multi-functional printer (secured not shared)
Small (101 to 200 Learners)	Shared, non-networked end-user devices with printing services	This option would apply to small schools where more than one end-user device is warranted, such as to a separate building in a larger school where network services are not essential and the cost of providing networked access is not justified.	1 laptop and 1 printer (not shared)	2 desktop computers and 1 multi-functional printer (secured shared)
Medium (201 to 500 learners)	Two-location shared networked end-user devices with shared and secure printing services	This option is not recommended except where a review of the requirements and circumstances of the school are well-aligned to its characteristics (i.e. smaller environments).	1 laptop and 1 printer (not shared)	3 desktop computers and 2 multi-functional printers (1 secured and 1 shared)
Medium / Large (501 to 1000 learners)	Two-location shared networked end-user devices with shared and secure printing services	This option is not recommended except where a review of the requirements and circumstances of the school are well-aligned to its characteristics (i.e. smaller environments).	1 laptop and 1 printer (not shared)	3 desktop computers and 2 multi-functional printers (1 secured and 1 shared)
Large (1001 to 1500 learners)	Shared networked end-user devices with shared and secure printing services	This model is not generally recommended for administrative support staff or management. This is the initial recommended default model for teachers with administrative activities.	1 laptop and 1 printer (not shared)	4 desktop computers and 2 multi-functional printers (1 secured and 1 shared)

School	Model	Justification	Computer Infrastructure	
			Principals	Administrators and Managers
Super Large (1500 + learners)	Networked device per user with shared and secure printing services	This option is recommended for larger schools.	1 laptop and 1 printer (not shared)	5 desktop computers and 2 multi-functional printers (1 secured and 1 shared)

2.3.1 ICT Options for Administrators and Managers

Through discussion with representatives from the provincial Departments of Education, it was confirmed that their current initiatives provide between one to two desktop computers to each school respectively for administration use within a school.

The recommendation of providing laptops to principals is based on the premise that principals are required to be more mobile, as they regularly have to attend management meetings either away from the school or after hours at the school. It is also in line with the Department's Teacher Laptop Initiative designed to encourage educators to use technology to make their teaching more effective in terms of content and presentation.

During the Option Analysis, it was indicated that initial rollout of end-user devices for administrators and managers should consist of computers being shared by two or more managers and administrators, but ultimately each manager and administrator should either be provided a laptop or a desktop computer. During the 2007 'Snap Survey', schools indicated that a total of 23,154 administrative staff have been employed at 13,742 schools, of whom approximately a third is employed by School Governing Bodies. The number of administrative staff per school varies between one and ten, with only a few schools having more than ten.

The recommendation of providing laptop and desktop computers to principals, administrators, and managers based on size of the school is therefore confirmed. (See paragraph 2.3.2 below with regards to the analysis of 'smart', 'thin', and 'fat' clients).

2.3.2 Unmanaged Clients vs Managed Clients

2.3.2.1 Introduction

Recommendation four of the Options Analysis recommended: 'Roll out a single ICT Lab to all schools registered to offer IT and CAT'. Due to the magnitude of this part of the e-Education Initiative in terms of costs, an assessment was performed as to which client solution (smart, thin, or fat) could be viable.

The terminology of thin and fat clients has been used since the early days of mainframes (thin clients / dumb terminals) and desktop computers (fat clients). With the introduction of client server architectures, this terminology was further complicated, as the terms thin and fat clients were also used to describe the software being deployed. It is therefore very important to determine whether the terminology is used in a hardware or software context, when reading and interpreting publications or research.

Smart and thin (managed) clients and fat (unmanaged) clients are defined as follows:

> A **thin** client (sometimes also called a lean client) is a client computer or client software used in client-server architecture networks which depends on the central server for processing activities, and mainly focuses on conveying input and output between the user and the server. A thin client computer therefore does not require large storage media and could also function with minimal memory. The applications and data reside on the server.[2] These are 'managed' clients.
>
> A **smart** client (or 'thick-client') is a client computer or client software in client-server architecture networks which typically provides rich functionality independently of the central server. Typically only some of the applications reside on the smart client computer. A smart client is connected to a network or central server, but is characterized by the ability to perform some functions without a connection to the server.[3] These are also 'managed' clients.
>
> A **fat** client is typically a stand-alone client computer or client software in client-server architecture networks which typically provides all functionality independently of the central server. Typically all the applications reside on the fat client computer. A fat client could be connected to a network or central server, but is characterized by the ability to perform many functions without a connection to the server. It is also usually characterized by a requirement to install a specific application on the computer.[4] These are normally 'unmanaged' clients.

The following misconceptions exist when comparing thin and fat client computers.

- *Any software application can be categorized as either fat or thin.*
  With fat clients, applications typically reside on, and run on, the user's workstation, whereas with thin clients most applications reside on, and run on, one or more servers. In fact, client/server software has a range of architectures. Some designs may strike an even balance between what runs on the client and what runs on the server. Some may have characteristics associated with 'fat' clients and some with 'thin' clients. It is even possible for a 'fat client' to run as 'thin' using technologies such as Citrix or Microsoft Terminal Server.

- *Thin client always means 'web browser'.*
  Thinness has to do with where processing happens, not the specific technology that implements it. It is therefore possible that certain applications may be run as thin clients.

- *Fat clients have local databases, thin ones do not.*
  Thin clients rarely have local databases, but fat clients sometimes do, depending on the application used. A fat client could operate with a local database, and download data to a host in batches, but it may also be configured to connect directly to a remote database and update in real time. A thin client, by definition, is limited in the amount of processing it can perform on the client computer; fat clients have no such limitations.

- *Fat clients are harder to deploy than thin clients.*

[2] Wilipedia.com.
[3] Wilipedia.com.
[4] Wilipedia.com.

While this can sometimes be the case, this does not imply that this is always so. Some software requires that additional pieces of software are installed, thereby granting greater functionality to the user. An example of this is the many web browser applications that may be used. These may require installation of plug-ins, they may require complex downloading of security certificates, and there are large potential problems brought on by the fact that not everyone uses the same web browser or the same version of the browser. The browser version issue becomes more acute when the browser is asked to do more of the application's processing through scripts, plug-ins, applets, and active server pages. However, software that might be seen as 'fat' can be installed and updated through web interfaces. Many software applications are nowadays automatically updated across the Internet.

- *Thin clients are easier to use.*
  Thin clients do less processing on the user's workstation, with the result that they are typically less interactive, have less efficient user interfaces, and are therefore harder to use than a well-designed fat client.

- *Thin clients run faster than fat clients.*
  This depends on how the application is built. On any modern workstation, there is a tremendous amount of processing power that is rarely used (i.e. wasted). Thin clients typically waste more than fat ones. On the other hand, overworked servers are common, and thin clients make this worse by offloading their processing to the server computer. Thin client overload of servers can be reduced by using more than one server in a 'three-tier' model, where there are separate application and database servers. However, three-tier applications are complex to deploy and administer.[5]

2.3.2.2 Strengths of Thin and Fat Clients

Smart clients typically combine the strengths of thin and fat clients. For this reason, we have only included the strengths and weaknesses of the extreme solutions.

Thin clients

- Lower IT administration costs. Thin clients are managed almost entirely at the server. The hardware has fewer points of failure, and the client is simpler (and often lacks permanent storage), providing protection from malware.
- Thin clients are easier to secure. Thin clients can be designed so that minimal application data ever resides on the client (just whatever is displayed), centralizing malware protection and reducing the risks of physical data theft.
- Enhanced data security. Should a thin-client device suffer serious mishap or accident, no data will be lost, as it resides on the terminal server and not the point-of-operation device.
- Lower hardware costs. Thin client hardware is generally cheaper because it does not contain a disk, application memory, or powerful processor. Thin clients also generally have run for longer period before requiring an upgrade or becoming obsolete. The total hardware requirements for a thin client system (including both servers and clients) are usually much lower compared to a system with fat clients. One reason for this is that the hardware is better used. A central processing unit (CPU) in a fat workstation is idle most of the time. With thin clients, memory can be shared. If several users are running the same application, it only needs to be loaded into random access memory (RAM) once

[5] http://www.ntst.com/solutions/public%20health/FatVsThin.asp.

with a central server. With fat clients, each workstation must run its own copy of the programme in memory.

- Less Energy Consumption. Dedicated thin client hardware has much lower energy consumption than fat client computers. This not only reduces energy costs, but may mean that, in some cases, air-conditioning systems are either not required or need not be upgraded. This can constitute a significant cost saving, as well as contributing to achieving energy-saving targets. However, more powerful servers and communications are required.
- Easier hardware failure management. If a thin client fails, a replacement can simply be swapped in while the client is repaired. Users are minimally inconvenienced because their data is not on the client.
- Worthless to most thieves. Thin client hardware, whether dedicated or simply older hardware that has been repurposed via cascading, is useless outside a client-server environment. Burglars interested in computer equipment have a much harder time selling thin client hardware.
- Effective operation in hostile environments. Most thin clients have no moving parts, so can be used in dusty environments without the worry of PC fans clogging up and overheating and burning out the PC.
- Less network bandwidth. Since terminal servers typically reside on the same high-speed network backbone as file servers, most network traffic is confined to the server room. In a fat client environment, if a user opens a 10Mb document, 10MB is transferred from the file server to the client. When it is saved, another 10MB is transferred from the client to the server. Print has the same effect – another 10MB is sent over the network to the print server and then onward to the printer. In a thin client environment, only mouse movements, keystrokes and screen updates are transmitted from or to the end user. Over efficient protocols such as ICA or NX, this can consume as little as 5kbit/s bandwidth;
- More efficient use of computing resources. A typical fat client will be specified to cope with the maximum load the user needs, which can be inefficient when it is not used. In contrast, thin clients only use the exact amount of computing resources required by the current task – in a large network, there is a high probability the load from each user will fluctuate in a different cycle from that of another user (i.e. the peaks of one will more than likely correspond, time-wise, to the troughs of another).
- Simple hardware upgrade path. If peak resource usage is above a pre-defined limit, it is a relatively simple process to add another rack to a blade server (be it power, processing, or storage), boosting resources to exactly the amount required. Existing units can continue to serve alongside the new ones, whereas a fat client model generally requires that an entire desktop unit be replaced, resulting in down-time for the user and the problem of disposal of the old unit.
- Lower noise. The aforementioned removal of fans reduces the noise produced by the unit. This can create a more pleasant and productive working environment.
- Less wasted hardware. Computer hardware is very environmentally damaging. Thin clients can remain in service longer and ultimately produce less surplus computer hardware than an equivalent fat client installation.
- Provides remote capability with minimal connectivity requirements. This lowers costs and makes the application more manageable.[6]

Fat clients

[6] www.wikipedia.com & http://www.deniserv.com/pages/tech_platform.asp.

- Fewer server requirements. A fat client server does not require as high a level of performance as a thin client server (since the fat clients themselves do much of the application processing). This may result in cheaper servers, although, in practice, many thin client servers are actually equivalent to file servers in specifications except with additional memory.
- Better multimedia performance. Fat clients have advantages in multimedia-rich applications that would be bandwidth intensive if fully served. For example, fat clients are well suited for video editing and video gaming.
- More flexibility. On some operating systems (such as Microsoft Windows), software products are designed for personal computers that have their own local resources. Trying to run this software in a thin client environment can be difficult or impossible, especially for applications that have many shared objects or libraries that are accessed frequently.
- Better peripheral support. Thin clients are typically very small, sealed boxes with no possibility for internal expansion, and limited or no possibilities for external expansion. Even if, for example, a USB device can be physically attached to a thin client, the thin client software might not support peripherals beyond the basic input and output devices. Thus, it may not be compatible with graphics tablets, digital cameras, or scanners.
- Suitable for poor network connections. Thin clients can be unusually slow, or very frustrating to use, over a high latency network connection. Moreover, they do not work at all when the network is down. It may be possible to work offline with a fat client, although the network-oriented manner in which many people work today means that fat client usage can still be curtailed if the network is down.
- Easier to repurpose. Clients may be used in thin client applications when they become obsolete for fat client use. Because it is standard and can operate autonomously, fat client hardware is easier to resell or donate when it must be retired.
- Offline working. Fat clients have advantages in that a constant connection to the central server is often not required.[7]

2.3.2.3 Weaknesses of Thin and Fat Clients

Thin clients

- Higher specification server required. As most of the processing is done on a server instead of the end-user device, high server performance is required.
- Single point of failure. The server is a single point of failure. In turn, this typically generates a cost of built-in hardware redundancy. Failure of a communication link (LAN or WAN) between the server and the thin client will render the thin client unusable.
- Multimedia performance. Thin clients are not ideal for multimedia performance. Most multimedia is processed by the server, and is passed as a screen to the thin client. This is network intensive and poor performance can result from inadequate networks or server bandwidth.
- Network requirements. Thin client devices rely heavily on sufficient and reliable network bandwidth to provide an adequate service. The technology is not suitable for poor network connections (LAN or WAN).
- Compatible software. Whilst most popular software (for example, Microsoft Office) can be used by thin clients, there are definitely fewer software choices. There is no apparent general availability of thin client software in the learning environment.

[7]www.wikipedia.com & http://www.denisery.com/pages/tech_platform.asp.

- Server support. Thin client networks require strong technical server management skills, although much of this can be applied from central locations at the cost of bandwidth and the network specification.[8]

Fat clients

- Technical skills. Desktops require skilled resources for installation. They should not be moved between locations by untrained staff, thus creating a requirement for the Institution to employ properly trained staff or rely on third parties.
- Commercially marketed desktops are, by their nature, designed to satisfy as wide a range of market needs as possible. This can result in some components, (for example, DVD players, certain ports, and hard drive disc space) being under- or unused. For a high unit-volume requirement such as that of the e-Education Initiative, this may be mitigated in part by the Institution specifying the technology components in some detail, which will result in a reduction in costs.
- Life span. In a commercial environment, a desktop computer is considered to have a useful life of approximately three to five years. This arises from a combination of the mean time between failure of significant components, availability of spare parts, and the relative cost of replacement versus repair. The useful life of desktop computers may be extended as in the case with refurbished computers, although new versions of software tend to create problems on older hardware. The effects of this weakness can be mitigated by careful hardware and software maintenance and refreshment strategies.
- Risk of theft. Owing to their ubiquitous nature, standard commercially-marketed desktops present attractive targets for thieves.[9]

2.3.2.4 Software Cycles (Smart clients / Managed clients)

A repeated cycle in the software industry has been the constant flux between thin client and fat client technologies. In the 1980s, a lot of software was still being developed for the mainframe, which were basically 'thin client' applications (i.e. centralized computing with 'dumb terminals' acting as the primary interface). The software could be updated on a single server, security was simpler, and viruses and other malware were not a big issue.

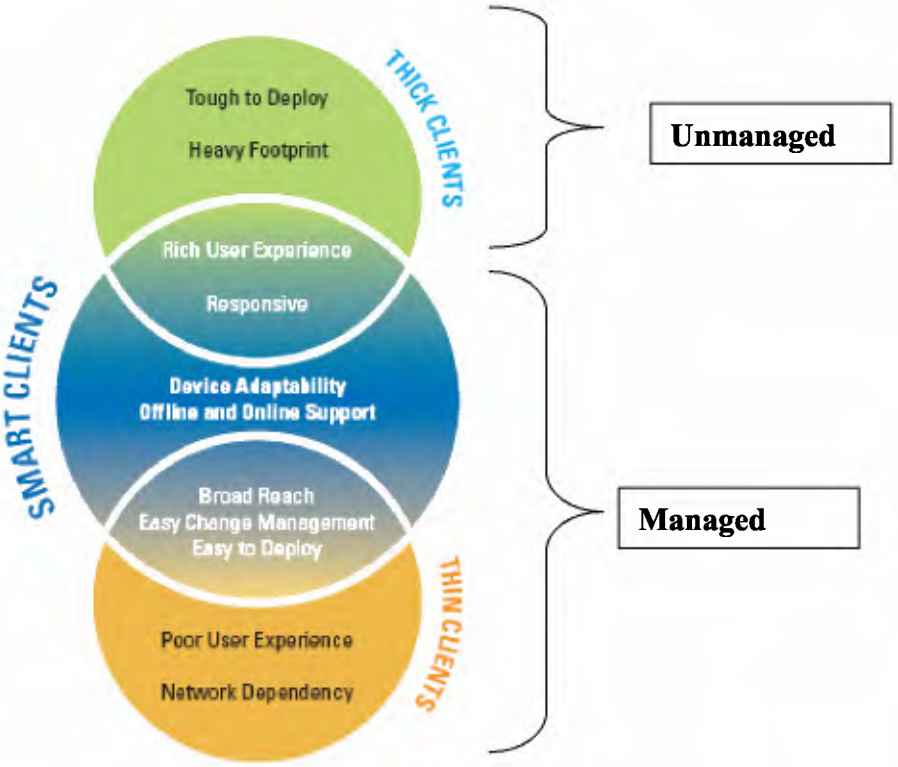
The next cycle was the 'fat client' wave in the form of client-server architectures. The reason for this shift was because the processing power in the PC could be leveraged to create better (and more usable) applications. This led to rethinking of how applications were designed, built, and deployed.

In the late 1990s, there was a shift back to thin clients, but to a much smarter client in the form of a web browser. This trend was fuelled by various factors:

- It is very difficult to manage desktop applications on multiple desktops;
- Certain applications exist where the server capacity and data storage required exceeded that of most PCs; and
- Internet standards made it relatively easy to build applications that would work across a variety of hardware platforms and operating systems.

[8] e-Education Feasibility Study Option Analysis Appendix 14.
[9] e-Education Feasibility Study Option Analysis Appendix 14.

History is repeating itself. The last four years have seen another cycle in the shift back to the 'fat client', but this time trying to encapsulate the benefits and developments of the previous cycles.



The cause for this change is indicative that there are still problems with the user interface. Consequently, to harness the benefits of both worlds, new 'smart client' applications will be self-updating over the Internet or network. Next-generation clients therefore use a combination of 'local storage' and server-side storage (at the option of the user and the developer). This cycle also introduces the concept of managed versus unmanaged clients.

Some of the main benefits of managed clients are:

- Less costly, representing increased value for money;
- Support and upgrades performed centrally; and
- Reduced security risk.

2.3.2.5 Convertibility of Fat Clients to Smart Clients

Because some schools have already implemented ICT laboratories, it is assumed that they have implemented mostly fat clients or stand-alone PCs in their laboratories. Fat clients can be converted into smart clients, as the conversion would only affect use of the computer but not require any changes to its hardware configuration. This may be achieved through use of technology such as Citrix, Terminal Services from Microsoft, and Go-Global from Graphon, which make it possible to install the fat client on a central server. To users, it appears as if they are running the application on their local workstation while in fact it is being run from the server. (For example, the 'picture' of the application is being sent from the server to the

workstation while the mouse movements and key strokes are being sent from the workstation to the server).[10]

2.3.2.6 Electricity Usage

One key factor influencing decisions today is the matter of energy consumption, not just because of concerns about supply but also due to the inherent cost related to the amount of electricity used. Other factors such as environmental consciousness have led to recent hot topics such as 'Green IT' initiatives which companies are able to implement on their own. The decision to use thin or fat client end user devices therefore has to consider the impact of actual electricity consumption of these and other devices (i.e. LCD vs cathode-ray tube monitors).

A recent comparison of energy use of desktop computers compared to thin client computers was performed for Wyse Technology Inc, suppliers of thin client devices.[11] It revealed that energy consumption of a regular desktop computer is far greater than that of modern thin client comparisons. The following table compares energy usage between regular desktop computers (requiring an average of 175 watts of electricity)[12] to that of the devices described above. The table also illustrates the energy requirements for a single laboratory of 45 computers.

Table 2 Comparison of energy use of a desktop computer to Wyse Technologies thin / smart client

Device	Single Unit	Energy Requirement for a Laboratory of 45 Computers
Fat client	175 watts	7, 875 watts
Thin / smart client (average of various models)	92 watts	4, 140 watts

In a separate study performed by Neoware, manufacturers of thin client devices, it was found that thin clients can use up to 90% less electricity than regular desktop computers.[13]

Table 3 Comparison of energy use of a desktop computer to Neoware thin / smart client

Device	Single Unit	Energy Requirement for a Laboratory of 45 Computers
Fat client	280 watts	12, 600 watts
Thin / Smart client (average of various models)	48 watts	2, 160 watts

As per tables illustrate, there is a significant difference in the energy consumption of regular desktop computers relative to thin clients. Not only will this have a direct effect on the operational cost of schools, but the additional load may even have a significant impact on the school's current energy supply.

[10] http://www.deniserv.com/pages/tech_platform.asp.
[11] Desktop Energy Consumption, A Comparison of Thin Clients and PCs.
[12] http://mrzonbu.wordpress.com/2007/07/23/how-much-power-does-your-desktop-pc-use/
[13] http://www.thinclient.org/archives/2007/08/green_energy_ne.html

2.3.2.7 Recommendation

Based on the strengths and weaknesses described above, the following recommendations are made regarding use of unmanaged (fat clients) or managed (thin/smart clients) for administrators and managers, as well as educators and learners.

Administrative and Management Environment
Given administrative and management staff's requirement to perform day-to-day operations and to communicate with other parties, the ability to perform work even when connectivity to the greater WAN may be lost is more important than the advantages which a thin/ smart client environment provides. It is, therefore, recommended that administrators and managers be provided initially with 'fat' desktop computers which are linked to the local area network (LAN). However, use of smart/managed client software should also be considered. Depending on the specific needs of the school, should the need arise, this could be changed over time through the school ICT Development Plans.

Educators and Learners (ICT Laboratories for IT and CAT)
Use of computers within ICT laboratories are driven by curriculum requirements, specifically addressing the subject requirements of Computer Applications Technology (CAT) and Information Technology (IT). Considering the number of computers necessary in each required laboratory (ranging from 20 to 45 computers), the benefits described above, and the significant cost and electricity usage implications, it is recommended that smart or managed client hardware and software be used within all ICT laboratories.

As the e-readiness of educators and learners increase, use ICT in schools will evolve from the ICT laboratory to the classroom. This need can be procured through the School ICT Development Plans as needs change.

2.4 Green IT

2.4.1 Introduction

'Global warming' and 'climate change', whether discussed in a local or international context, have become increasingly important topics for some time. Natural disasters and rising temperatures have contributed to increasing social and corporate consciousness about the protection of the environment.

It is becoming clear that the manner in which we live our daily lives and conduct our business is having a harmful impact on our environment and the climate. As the global population increases, so does the demand for energy. Likewise, the demand for IT related equipment and consumables have also increased. Because IT equipment has a relatively short life span, another key environmental concern relates to disposal of such equipment, as this may give rise to possible dumping of outdated IT equipment. To address this and other concerns, a number of relevant environmental initiatives are documented.

2.4.2 Recycling Electronic and Electrical Equipment and Management of e-Waste

Modern lifestyles have become increasingly dependent on electrical and electronic equipment (EEE). As a result of the decreasing costs of EEE and increasing rates of obsolescence, large quantities of these products are becoming redundant as users upgrade or exchange their products for more recent versions.

A formal definition of e-waste, also known as Waste from Electronic and Electrical Equipment (WEEE), does not exist. However, it is generally accepted as referring to electronic equipment that no longer holds economic value for its owner. E-waste includes electronic devices ranging from large household items to computer equipment and cell phones. Per Directive 2002/96/EC of the European parliament and of the council of 27 January 2003 on WEEE, there are ten categories of e-waste. These are defined below:[14]

Table 4 Categories of e-waste

No	Name	Category Label
1	Large household appliances	Large HH
2	Small household appliances	Small HH
3	IT and telecommunications equipment	ICT
4	Consumer equipment	CE
5	Lighting equipment	Lighting
6	Electrical and electronic tools (with the exception of large-scale stationary industrial tools)	E & E tools
7	Toys, leisure and sports equipment	Toys
8	Medical devices (with the exception of all implanted and infected products)	Medical equipment
9	Monitoring and control instruments	M & C
10	Automatic dispensers	Dispensers

At present, e-waste represents the largest growing segment of the municipal waste stream.[15] Due to the nature of e-waste, it is difficult to regulate and accurately monitor how much is being generated. It is estimated, however, that categories 1 to 4 in the table above account for approximately 95 percent of all e-waste, with large household appliances and IT and telecommunications equipment contributing to 75 percent of the total.[16]

Developed nations currently produce the highest rate of e-waste per capita due to the level of industrialization in these countries. However, as EEE becomes more and more a part of everyday life in developing nations, these countries, led by China and India, are now increasingly contributing to the generation of e-waste.[17] Indeed, it is expected that developing countries will become the fastest growing contributors to the e-waste market, with the potential to triple their e-waste output by 2010.

[14] Source: WEEE categories according to the EU directive 2002/96/EC on WEEE
[15] BBC News
[16] Widmer, R., Oswald-Krapf, H., Sinha-Khetriwal, D., Schnellmann, M., and Boni, H. [2005]. Global Perspectives on e-waste. Environmental Impact Assessment Review. No.25, pp.436– 458.
[17] United Nations Environment Programme

The main sources of e-waste can be divided into three categories, as indicated in the table below:[18]

Table 5 Main sources of e-waste

No	Category	Description
1	Individual households and small businesses	Due to increasing adoption of technology in daily life, there is an excess of electronic and electrical equipment that have become standard features in both households and small businesses. The largest portion of this equipment is made up of 'white goods' such as refrigerators and washing machines. This is followed by televisions and personal computers.
2	Large businesses, educational institutions, governments	Office equipment, such as personal computers, printers, photocopiers, and fax machines contribute to generation of e-waste by these users of electronic and electrical equipment. This is due to large businesses, educational institutions, and government agencies using the majority of computer equipment and peripherals. These users tend to lease their equipment from the companies that produce them, and it is these companies that bear responsibility to dispose of the equipment. This most commonly takes the form of the company taking back the equipment and providing the user with a replacement or upgraded version of the product.
3	Original Equipment Manufacturers	E-waste is generated during the manufacturing process as a result of defective or sub-optimal quality components. In addition, e-waste is generated along the supply chain in the form of individual components, sub-assemblies, or semi-finished products. Another source of e-waste from original equipment manufacturers is from product recovery and refurbishing operations.

Waste has long been an area of concern for environmentalists, but in recent years; e-waste has become a specific area of growing concern. This stems primarily from two factors:

- E-waste includes over a thousand different substances, varying from valuable raw materials to toxic substances that may be released if equipment is not properly handled. Toxicity of e-waste, and the health risks related to this, make it especially dangerous.
- In spite of global conventions in place to restrict the movement of e-waste, such as the Basel Convention and the Bamako Convention, vast amounts of e-waste are still being exported from developed to developing nations under the guise of recycling. Developing nations do not generally have formal e-waste recycling legislation and methods in place to deal effectively with the vast amounts of e-waste that they receive.

2.4.3 e-Waste Legislation

In 1992, the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal came into effect[19]. The Basel Convention is a global agreement governing treatment of all hazardous waste, including e-waste. According to the Basel Convention, the country exporting hazardous waste bears responsibility for ensuring that it is managed in an environmentally-friendly manner within the country to which it has been

[18] Source: United Nations Environment Programme

[19] Sinha-Khetriwal, D., Widmer, R., Schluep,. M, Eugster, M., Wang, X., Lombard, R., and Ecroignard, E. (2006). Legislating e-waste management: progress from various countries. Environmental Law Network International.

exported. In total, 164 countries have ratified the convention, with only Afghanistan, Haiti, and the United States of America (USA) yet to ratify the convention. As one of the largest producers of e-waste non-ratification by the USA has seriously limited the ability of the convention to govern e-waste effectively.

In response to the Basel Convention, the Organization of African Unity (OAU) drafted the Bamako Convention on the Ban of the Import into Africa and the Control of Trans-Boundary Movement and Management of Hazardous Wastes within Africa in 1991. The Bamako Convention entered into force in 1998, and is considered to be one of the strongest control measures on waste ever passed. This is due to use of the precautionary principle, which judges a substance to be hazardous until it is proven safe. To date, this convention has been ratified by 21 African countries.

In 2004, the WEEE Directive came into force in Europe. It deals with the end of life of EEE by applying the principle of Extended Producer Responsibility (EPR). The EPR principle requires producers of equipment to bear financial responsibility for the environmental impact of their products, especially when these products become waste. This has led to the inclusion of waste-related environmental costs in the price of equipment. The requirements of the WEEE Directive have been formalized in the United Kingdom in the form of the 2007 WEEE Regulations.

In addition to legislation governing the end of life of EEE, the 2006 Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive governs use of hazardous materials in the production of EEE. The RoHS Directive limits the levels of hazardous materials that may be used in EEE in the European Union (EU) market. This has a broader international impact, as countries wishing to engage in business with EU countries must comply with the RoHS Directive.

Within South Africa, three key acts exist to govern waste management:[20].

- The National Environmental Management Act (Act 107 of 1998) (NEMA) is intended to provide the principal framework for integrating good environmental management into all development activities. NEMA makes provision for waste management through avoidance or minimization and remediation of pollution, including waste reduction, re-use, recycling, and proper waste disposal, and the 'polluter pays' and 'cradle to grave' principles.
- The Municipal Services Act (Act 32 of 2000) provides the principles and mechanisms to achieve effective governance at the local level, and includes implications for the environmental management function exercised by local government (which includes waste management).
- The Hazardous Substances Act (Act No. 15 of 1973) provides the regulations to control the management of hazardous substances and the disposal of hazardous waste.

Although these acts exist, there is currently no specific legislation governing the treatment of e-waste. In addition, while South Africa has ratified the Basel Convention, it has not ratified the Bamako Convention. Increasing pressure is being placed on South Africa by non-governmental organizations to take a stronger stance on trade of e-waste.

[20] e-Waste Guide South Africa

2.4.4 Recycling e-Waste

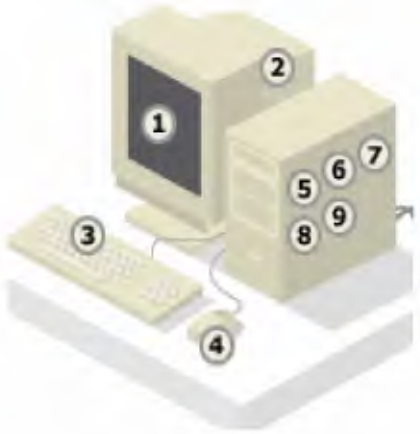
As part of the generic product lifecycle there are many ways in which the life of a product may be extended before it is finally disposed of. These approaches are outlined below:

- Reuse: recovery and trade of used products or their components as originally designed.
- Servicing: a strategy aimed at extending the usage stage of a product by repair or maintenance.
- Remanufacturing: the process of removing specific parts of the waste product for further reuse in new products.
- Recycling (with or without disassembly): including the treatment, recovery, and reprocessing of materials contained in the used products or components in order to replace the virgin materials in the production of new goods.
- Disposal: the processes of incineration (with or without energy recovery) or landfill.

At present, however, e-waste often ends up in landfills or incinerators instead of being recycled, with the result that toxic substances like lead, cadmium, and mercury that are commonly used in these products can contaminate land, water, and air, having a devastating impact upon both the communities in these areas and the environment[21].

The following illustration provides some insight as to what toxic substances are present in a traditional desktop computer.

1) Lead in cathode ray tubes and solders;
2) Arsenic in older cathode ray tubes;
3) Selenium in circuit boards as power supply rectifier;
4) Polybrominated flame retardants in plastic casings, cables, and circuit boards;
5) Antimony trioxide as flame retardant;
6) Cadmium in circuit boards and semiconductors;
7) Chromium in steel as corrosion protection;
8) Cobalt in steel for structure and magnetivity; and
9) Mercury in switches and housing.



2.4.5 Donation or Reuse

Donations and reuse extend the life of an appliance, as there is a shift in ownership, rather than final disposal. Donations are frequently made to charitable institutions or to economically weaker sections of society. There are some charitable institutions that collect discarded equipment, especially televisions, PCs, and cellular telephones for donations to developing and low-income countries in Asia and Africa. However, this practice is hotly debated, as it often leads to dumping of e-waste by rich countries in poor ones, saddling them with the burden of safe disposal. However, as a certain amount of EEE that is discarded by its original owners is still in working condition, reuse of EEE is a common intermediate step that extends its usable life. Often, intermediaries provide channels for reuse, such as second-hand equipment sellers, or online auction sites.

[21] Mayfield, Kendra. (2003). E-Waste: Dark Side of Digital Age. Wired Magazine.

2.4.6 Servicing (Also known as 'Corporate Take-Back Programmes')

Several large IT equipment manufacturers have started take-back and asset recovery programmes for their clients, mainly large business users, through which they take back their old equipment at the time of purchase of the new equipment. This is then either refurbished and resold in the second hand market, or sent for dismantling and recovery operations. However, these services are limited only to few markets in Europe, America and Japan.

2.4.7 Exporting, Recycling, and Remanufacturing

2.4.7.1 Exports

Although e-waste is incorporated under the heading of hazardous waste in the Basel Convention, the ability to recover valuable raw materials such as gold and copper has led to a growing trade in e-waste. In recent years, both China and India, traditional recipients of e-waste dumping, have introduced tighter regulations over the trade of e-waste. This has resulted in more and more e-waste ending up on African shores, notwithstanding the Basel and Bamako Conventions.

Inspections of 18 European seaports by Greenpeace in 2005 found that as much as 47 percent of waste destined for export, including e-waste, was illegal. In the United Kingdom alone, at least 23,000 metric tonnes of undeclared or 'grey' market electronic waste was illegally shipped in 2003 to the Far East, India, Africa, and China. In the USA, it is estimated that 50 to 80 percent of the waste collected for recycling is being exported in this way. This practice is, however, not yet strictly illegal because the USA has not ratified the Basel Convention.

The Basel Action Network (BAN) reports that, in Nigeria alone, about 500 containers full of used electronic cargo pass through the Lagos port every month. According to the BBC, experts speculate that anywhere between 25 to 75 percent of the e-waste that enters Africa (mostly through Mombasa, Lagos, and Dar es Salaam) is useless and ends up in landfills. On these dumps, children scavenge for valuable raw materials such as copper cabling in order to earn approximately US$2 a day by collecting components. In doing this, however, they are also putting their health seriously at risk. Research at Nigeria's University of Ibadan warned of a 'chemical time bomb scenario', with children highly susceptible to toxic substances which could lead to long term cancers affecting the lungs and all parts of the body.

In light of this growing trade and its apparent dangers, an amendment to the Basel Convention was proposed in 1995 requiring that all transportation of e-waste from developed nations to developing nations be banned entirely. This amendment, known as the Basel Ban, has not been ratified by several developed nations and as such has not come into effect.

2.4.7.2 Recycling of Functions and Materials

E-waste recycling can include several activities such as dismantling, sorting and segregation, remanufacturing and recovery operations. These processes can be done mechanically or manually. Recycling of e-waste is gaining importance considering the precious metals it contains. Although recycling can be a good way to reuse the raw materials in a product, the

hazardous chemicals in e-waste mean that electronics can harm workers in the recycling yards, as well as their neighbouring communities and environment.[22]

In developed countries, electronics recycling generally takes place in purpose-built recycling plants under controlled conditions. In developing countries, however, EEE is often recycled without the necessary environmental health and safety checks in place, exposing both workers and the environment to toxic emissions[17].

Common techniques are:

- Stripping of metals in open-pit acid baths to recover gold and other metal;
- Removing electronic components from printed circuit boards by heating over a grill using honeycombed coal blocks (coal mixed with river sediment which is contaminated) as fuel;
- Chipping and melting plastics without proper ventilation;
- Burning cables for recovering metals, and also burning unwanted materials in open air; and
- Disposing unsalvageable materials in the fields and riverbanks.

These techniques of recycling are hazardous, uncontrolled, and, due to the cheap labour used, often exploited by developed nations to the detriment of local communities in these developing nations.

2.4.8 Disposal

2.4.8.1 Landfills

Land-filling of e-waste is a common practice, especially where there is no separate collection and recycling system for e-waste. Landfills are, however, prone to leaking, and e-waste disposed of in landfills can leach heavy metals and other toxins into the soil and more dangerously contaminate local water and food supplies. Mercury, Cadmium and Lead are among the most toxic leachates. In addition, landfills are prone to uncontrolled fires which can release the toxic chemicals in EEE into the atmosphere, impacting nearby communities and the environment.

In light of these dangers, regulations have been introduced in many European countries to prevent e-waste being dumped in landfills due to its hazardous content. However, the practice still continues in many countries, especially developing nations on the Asian and African continents. In Hong Kong for example, it is estimated that 10 to 20 percent of discarded computers go into landfills.

2.4.8.2 Incineration

Incineration is a commonly used disposal mechanism for municipal solid waste. In such cases, when e-waste is disposed of with regular waste, it is also incinerated with the rest of the waste as it is difficult to separate. As with burning landfills, this releases toxic gases and ash into the environment.

[22] Greenpeace.

2.4.8.3 Storage

For most EEE consumers, both large and small, storage is the first step in the e-waste disposal chain. According to a study by the eWaste Working Group South Africa (eWASA), South Africa has approximately 70 percent of its e-waste held in storage. This is, however, a temporary solution as the waste will need to be disposed of at some point in time and will consequently become a part of the waste stream.

2.4.8.4 Corporate Initiatives

In line with the WEEE directive, some manufacturers are beginning to assume greater responsibility for what happens to their products after they become obsolete. For example, Dell, Hewlett-Packard and Gateway have recently expanded programmes to collect old computer equipment.

2.4.9 'Greening' of Data Centres

The greatest power consumption within an organization is by the IT department, with IT systems and the related infrastructure accounting for approximately a third to half of a company's energy usage. The rate of consumption is only expected to rise with growth in use of IT. Taking into consideration rising energy costs, IT directors are looking to use more energy-efficient and cost-effective mechanisms in servicing the business. The area that has been identified as the most ineffective is the data centre.

Data centres were initially designed with a few servers and mainframes in mind, and with a strategy of providing maximum up-time for users. Since then, however, there has been immense growth in IT departments and the reliance placed on IT is growing significantly, resulting in these centres being used to house all of the organization's application servers. However, the strategy for maintaining these centres has not changes significantly since the initial conception of the data centre, so a considerable amount of energy is going to waste. In addition, environmental awareness and recent problems with electricity supply in South Africa are placing increasing pressure on IT departments of medium to large organizations to develop more energy-efficient and carbon-neutral data centres. Environmentally friendly data centres not keep down rapidly growing energy costs, but also provide organizations competitive advantage amongst the broader community.

The initial action taken by organizations is to assess energy usage and thermal dynamics within their current environment to determine the areas of greatest concern. The following mechanisms can then be used by organizations to make data centres more energy-efficient:

- Recycle: recycle redundant hardware effectively.
- Streamline: ensure that hardware resources are efficiently used and reduce any redundant resources.
- Thermo-Dynamic Analysis: obtain an understanding of the data centre's cooling requirements and curb any energy wastage due to cooling.
- Access: perform an assessment of the current power consumption within the data centre environment.

Three mechanisms are used to increase the level of efficiency and reduce energy consumption in the identified areas:

1) *Effective Cooling Mechanisms*
   Data centres are still typically still cooled in manner similar to when they were initially designed, but the centre environment has since transformed in ways that require newer and more innovative cooling methods. With this new demand in the market, computer manufacturers are developing air conditioning systems that use sensors and fans that work in combination with server racks to cool servers more efficiently. Alternatively, liquid cooling solutions can be used for servers enclosed within the data centre and can be a more efficient solution for transferring the heat of the processors outside. However, these cooling mechanisms need to be monitored and analysed on a continuous basis to ensure that the techniques used remain energy efficient.

2) *Efficient use of resources*
   A fast and efficient way of reducing power consumption within a data centre is to reduce the number of devices in the centre by means of 'virtualization'. The concept of virtualization enables several instances of an operating system to run on one physical server (i.e. thin client devices). With successful implementation and management, virtualized servers can process at 80% of their capacity.

3) *Use of less power-intensive technology*
   In instances where organizations wish to replace their entire data centre with energy efficient servers and systems, modular systems can be implemented to ensure that only the required energy is used. In addition, mechanical and electrical systems can be synchronized to run at optimal efficiency. The data centre can also be built using recycled and low emission materials and preferably solar or wind power. This mechanism is, however not feasible in many instances as replacement of the data centre requires significant capital, and most organizations have an operating policy of purchasing new equipment only to replace old equipment.

Due to the significant power consumption of data centres, implementation of a green data centre will greatly assist in reducing carbon emissions of an organization. Additional benefits that could be realized with a green data centre initiative are increased reputation and a competitive advantage within the market space. This also promotes a healthier working environment for employees and adjacent communities. Finally, implementation of more energy efficient processes can lower operating costs by up to 60%.[23]

2.4.10 Application Within the e-Education Initiative

The e-Education Initiative will need to address the following environmental concerns:

- Guard against possible dumping of ICT hardware onto schools
  Even though schools in the past have received numerous donations from the private sector, concerns regarding possible dumping have only recently been addressed through the Department of Education's Norms and Standards for ICT hardware at schools. These Norms and Standards provide a minimum level of specifications for a variety of ICT hardware, which should be used to govern all purchases and donations, thereby helping to guard against the dumping of outdated hardware onto schools.

[23] Hewlett Packard

- Means by which ICT hardware at schools are disposed
  In relation to disposal of ICT hardware by schools, it is important that each school, governed by guidelines from the Department of Education, School Governing Bodies, and Local Authorities, conforms to an acceptable process through which outdated or retired hardware can be disposed of. This process should form part of the Educational ICT Development Plans of each school and integrated into the procurement and asset management processes of ICT hardware. It is important that the whole life-cycle of IT assets (from acquisition, maintenance and support, to disposal) be assessed as part of the selection criteria during the procurement process.

- Increasing effectiveness and efficiency of data centres (including ICT Laboratories)
  Even though schools in themselves will not implement large data centres, they will, with implementation of ICT in classrooms, be increasing the carbon footprint of schools. This should be done in ways that increase levels of energy efficiency and reduce energy consumption through effective use of cooling mechanisms, efficient use of resources, and purchase of more energy-efficient technologies.

2.5 The Current Energy Crisis in South Africa

During 2007 and 2008, energy supply in South Africa has reached a pinnacle and Government pleaded to the community (business and households) to save as much as possible on energy usage, especially during periods of peak use. The energy crisis escalated following the implementation of 'load sharing' which temporarily became a frequent occurrence throughout South Africa. During the beginning of 2008, the energy shortage had escalated to the point that supply to the mining and manufacturing industries was reduced to alleviate the burden on households. This led to some mines halting operations until the situation improved.[24][25][26][27][28] Later statements by Eskom indicated that energy supply to large scale construction developments (which had not yet received approval from Eskom) might be halted, until the situation was brought under control. This shortage in electricity has led to significant increase in investment by business and households, in small and large scale electricity generators. Unfortunately this crisis also came at a time when South Africa was faced with the highest fuel prices ever, which had a direct operational cost implication for companies and institutions reliant on this alternative measure for providing electricity to their operations.

In response to those energy shortages, Eskom has responded with a number of short- and long-term initiatives. These varied from increasing the coal reserves for coal-fired power stations and increasing electricity charges to offset demand to reinstating decommissioned power stations,[29] building additional power plants, providing alternative pricing for off-peak usage,[30] and conducting research in alternative energy generating options such as wind- and wave power.[31]

[24] http://www.iol.co.za/index.php?set_id=1&click_id=3053&art_id=nw20080308154645608C178546
[25] http://eskomplain.co.za/what-is-the-load-shedding-status/
[26] http://www.citypower.co.za/citypower_load_shedding.html
[27] http://www.mnet.co.za/Mnet/Shows/carteblanche/
[28] http://eskomplain.co.za/?s=implication+for+mines
[29] http://www.news24.com Article by Gcina Ntsaluba
[30] http://eskomplain.co.za/?s=energy+looking+at+more+options
[31] http://eskomplain.co.za/?s=generators

Eskom made significant progress in improving their business operations and in strengthening their infrastructure. To this end, they have successfully increased their stockpiles to healthier levels, at an average of 35 coal stockpile days and have also seen great improvement in their generation plant performance. Meanwhile, construction of their new power stations Medupi and Kusile is well under way. The two stations cost an estimated R80bn each, making the power station construction the biggest expansion programme currently being undertaken in South Africa. Eskom expect the first units of the two power stations to be operational by 2012/13. Although there has been no load shedding since May 2008, the electricity system still remains vulnerable due to the low reserve margin for the immediate future.[32]

Implementation of this e-Education Initiative requires that each school need to have sufficient electricity supply to meet its ICT power requirements. Although the current energy shortage in South Africa has a significant short term impact on the e-Education Initiative, it is however anticipated that this energy crisis should be resolved in the long run. Current indications are that Eskom is in the process of implementing the above-mentioned measures to be able to address future electricity needs.

2.5.1 Recommendation

Taking into consideration that this Initiative will be implemented over several years, energy shortages in South Africa should have been addressed and therefore this e-Education Initiative should not require any major electricity generation and supply initiatives (i.e. generators or solar power for all schools), other than where schools currently do not have any electricity. However, it is important that this Initiative incorporate the following two components:

- Uninterrupted power supplies (UPS) should be deployed as appropriate to mitigate the effect that power cuts (load sharing) might have on administrative and ICT-based educational activities in progress at the time of the loss of electricity.
- Effective use and saving of electricity should be achieved by procuring ICT equipment that is energy-efficient.

Some schools currently do not have access to grid electricity. To implement this Initiative at such schools, it will be important to assess electricity needs based on specific options that will be implemented at each school and ensure that such electricity needs can be met through alternative sources. The most effective electricity is that provided by the national grid, however should this source not be available, for whatever reason, alternative sources such as solar panels and generators should be considered.

2.6 Free and Open Source Software and Open Standards

2.6.1 Background

There are four key considerations when deciding on free and open source software (FOSS) implementation: availability, effectiveness, cost, and support. In this context, 'availability'

32 A Newsletter for Eskom Distribution Customers dated January 2009

refers to proprietary and FOSS options in use (i.e. what FOSS equivalents for proprietary systems are accessible, and FOSS options that can be expected to become available in the future). 'Effectiveness' refers to the extent to which each option aligns to the needs of the Institution. In the case of skills, this would include consideration of the adequacy of skills available, whilst, in the case of software, it would include the functional fit of the option and its use of computer and support resources. 'Cost' alludes to affordability and value for money presented by each option.

A common misperception is that FOSS is 'free' in the sense that it costs nothing to buy or use. The concept of 'total cost of ownership' (TCO) has been prevalent in the world of proprietary software for many years. The TCO concept equally applies to FOSS, as there are many costs besides those of acquiring and licensing the right to use software. These include, but are not limited to, costs associated with training users, hardware acquisition and upgrade costs, maintenance costs, and the cost of support skills. Whilst FOSS is generally, but not always, free to acquire and license,[33] all other elements of the TCO still apply.

Despite this, and because the costs of proprietary software can be high, significant savings are claimed from the use of FOSS. Examples of such claims include:

- NetProject.com reports that the TCO of Linux was 35 percent of Microsoft Window's TCO.[34]
- Gartner reported that using Linux in a 'locked' configuration[35] resulted in a roughly 15 percent lower TCO compared to Windows XP.[36]

The following case studies illustrate effective use and TCO of FOSS:

2.6.2 Case Study One: FOSS in Government[37]

2.6.2.1 Introduction

The city of Largo is one of the earliest high-profile cases of a government administration migrating over to Linux. The IT system of this small city in the state of Florida, USA, supports 800 city workers, including local safety and health services. Implementation began in 2000, and their experience with Linux in the years since then have been nothing but positive.

2.6.2.2 Motivation for migrating to Linux

In 2000, the IT Department of Largo was evaluating upgrade options, as problems were being encountered with existing OpenServer and UnixWare products from the Santa Cruz Operation. Various options were evaluated, including Microsoft Windows on personal computers. However, since the Department was already using a Unix-based thin-client infrastructure, the combination of hardware and software costs involved in such a migration was deemed prohibitively expensive. Additionally, the IT team did not want to be locked into

[33] In some cases, proprietary suppliers use FOSS as a basis to develop an enhanced product for which it may charge an initial costs and support fee.
[34] 'netproject – Cost of Ownership' available from http://www.netproject.com/opensource/coo.html.
[35] Users are prevented from changing configurations; this reduces user-caused problems and maintenance costs.
[36] Maguire, James, 'Windows vs. Linux: TCO Feud Rages On', 01 August 2003, *Newsfactor Network* [home page online]; available from http://www.newsfactor.com/perl/story/22012.html.
[37] An Initiative of the UNDP's Asia-Pacific Development Information Programme / Free/Open Source Software - A General Introduction (Kenneth Wong and Phet Sayo).

a two to three year upgrade cycle, where it would be forced to pay upgrade costs even when upgrades were not necessary. Ultimately, the decision was made to keep the existing thin-client infrastructure, but migrate systems to a Linux system based on Red Hat's distribution.

2.6.2.3 Implementation approach

A solution was tested and implemented, starting in 2000 and completed by mid-2001. Two powerful (for that time) dual-processor Compaq servers delivered the services needed by most users. A variety of FOSS and non-FOSS applications were combined, including Netscape (web browser), Evolution (email client), and WordPerfect 8 (word processor). Heavy-duty database needs were run on a proprietary Oracle database, while Microsoft's Excel and PowerPoint were made available to Linux users via a combination of Windows NT and the Citrix Metaframe server. In total, there were about 20 different servers working together, running a mix of Linux, Windows, and Unix operating systems.

On the desktop side, implementation models were simpler. The thin-client model requires only the barest minimum from desktop units. Hence, desktop units could be obtained at a relatively low cost. In some cases, the IT team managed to obtain desktop systems for as little as US$5 per unit. With ten-year lifespans and few moving parts, these desktop units rarely broke down and had a longer useful lifespan than normal PC desktops.

2.6.2.4 Results

The migration to Linux was estimated to have saved the city as much as US$1 million in the first year alone. Largo currently has an IT budget that is only about 40 percent the size of comparable cities. Where cities of a comparable size normally spend three to four percent of their city budget on IT, the Largo team gets along quite comfortably with only 1.3 percent of the city budget. The efficiency with which Linux uses hardware has also generated savings. The IT team estimated that it would not need to upgrade desktops until 2007.

The reduction in number of personnel required is also significant. The end-user help desk required only two to three people to support a user base of 800 workers. This low ratio was attributed to the reliability, stability, and predictability of the system. The remaining staff members of the city's ten-member IT department were then freed for other tasks, including making additional improvements to the IT infrastructure.

2.6.3 Case Study Two: FOSS in Education[38]

2.6.3.1 Introduction

The Goa Schools Computer Project (GSCP) was launched in the Indian state of Goa to provide affordable computer laboratories to secondary and higher secondary schools in the state. The first pilot projects were launched in 2000, and after evaluation a second, larger project was launched in 2002.

The GSCP is a collaboration involving public, private, and non-governmental organizations. The Goa Department of Education, Red Hat Linux, the Goa Computers in Schools Project NGO, and the Goa Sudharop Community Development Charity all contributed to making this

[38] An Initiative of the UNDP's Asia-Pacific Development Information Programme / Free/Open Source Software - A General Introduction (Kenneth Wong and Phet Sayo).

project a success. Using recycled computers and the FOSS GNU/Linux system, a total of 125 schools received computers that otherwise would not have been made available.

2.6.3.2 Motivation

Cost was a primary motive for using the GNU/Linux system, particularly the licensing cost of proprietary software. Because the project decided from the outset to recycle computers (also for cost reasons), finding software to place on these devices became a major issue. These devices were typically received with blank hard drives, due to concerns over security of the organizations donating the computers. Purchasing software to run on these computers would have multiplied the costs of using them.

By going with the recycled computer/GNU/Linux combination, the GSCP was able to install systems for as little as US$35 per system, with full computer laboratories, including networking, costing less than US$500. Proprietary software for a single computer would have cost at least US$400–500, many times the cost of the computer itself.

A comprehensive costing was performed for this project. Based on data from previous projects in other Indian states (Andhra Pradesh, Karnataka, Tamil Nadu and Kerala), it was estimated that the GNU/Linux/recyled hardware model would save as much as 77 percent of a traditional solution (proprietary software, new hardware). Combining GNU/Linux with new hardware would have saved 64 percent of the costs of the proprietary software/new hardware model.

2.6.3.3 Implementation Approach

The GSCP used refurbished computers imported from developed nations. These computers were typically outdated models, replaced in regular corporate upgrade cycles. After testing and refitting as necessary, the computers were installed with the GNU/Linux operating system. The larger installations (laboratories with more than four computers) used GNU/Linux in a thin-client configuration.

Each computer laboratory was typically a cooperative effort between GSCP and the local school. GSCP would supply equipment and teacher training, while the school would supply the UPS, wiring, and furniture for the laboratory. Once set up, the laboratory would be used by the schools during school hours and by the community at large after hours.

2.6.3.4 Results

A survey carried out one year after the computers were shipped found that 90 percent of the PCs had been installed and 76 percent were operational. Schools using the thin-client model, which were also the schools that received four or more PCs, fared best. Urban schools fared better than rural schools for various reasons, including better support and a larger number of available computers (due to larger student populations).

The schools are now charging 20 cents per student to pay for maintenance and Internet access. Pilot experiments are also underway to test the sustainability of charging the community for after-hours access to the computing facilities and the Internet. Experiences from projects in other countries have shown this to be feasible, and it is hoped that it will be just as successful in Goa.

2.6.4 Case Study Three: Replace FOSS in Education with Microsoft Software (Finland)

2.6.4.1 Introduction

During the Institution's review of the Options Analysis, Institution officials suggested that Finland's education system had at one time taken a decision to use FOSS, but that a strategic decision had now been taken to abandon FOSS and, instead, revert to use of Microsoft software. The Transaction Advisors were requested to investigate and report on the matter during the Due Diligence Phase.

Internet research was conducted into the alleged abandonment of FOSS in favour of Microsoft. As best can be determined from these sources, there appears to be no basis for concluding that Finland has changed its strategies. The research did, however, establish that:

- Microsoft offered to provide Live@edu (or Windows@edu) services to Finland's 500,000 students.[39] These services are described in the section below. The Live@edu services are Web browser based and are 'compatible with Windows, Mac and Linux machines, as well as Internet Explorer 5.0+ and 6+, Firefox 1.5+ and Safari 2.0 (Safari does not support JavaScript)'.[40]
- The Finnish News Agency (STT) wrongly reported that the 'school software works only with Microsoft's Windows operating system'.[41] As noted above the Live@edu services can be used in a FOSS environment (i.e. Linux).
- The Finnish Prime Minister (Mr. Matt Vanhanen) told STT in respect of any decision to be made by schools to use the Live@edu service that 'the schools can decide for themselves, it is no forced gift.'[42]

FOSS appears to fairly widely used in Finland. A report published by Finland's Häme Centre of Expertise in the winter of 2005[43] states that

> About 60% of Finnish schools (includes all school levels) are using open source software to carry out their school management, teaching and learning activities…75% of upper secondary schools, but only 27% of comprehensive schools use a learning platform or learning management system to deliver teaching and accomplish learning. The most frequently used open source learning platform is Moodle (www.moodle.org). Also, knowledge management systems are used by universities and schools, but these systems are most often propriety (sic) ones (open source products such as PHP-Nuke and Zope are being used by some schools)…Open office (74% of respondents), Mozilla's browser and email software (80.7%) as well as GIMP (36.4%) are fairly popular open source products among Finnish universities, polytechnics, and schools.

The report, however, cautions that its numbers should not be viewed as accurate due to low response percentages: universities 66%, polytechnics 38%, other schools (vocational, upper secondary and comprehensive schools) 10%.

On balance, no evidence has been found to show that Finland's education system has rejected FOSS and is reverting to Microsoft products. However, schools in the education system

[39] http://blog.seattlepi.nwsource/print.asp?entryID=129756
[40] http://get.liveatedu.com/Education/Connect/Works/
[41] http://virtual.finland.fi/stt/showarticle.asp?intNWSAID=17878&group=politics
[42] http://virtual.finland.fi/stt/showarticle.asp?intNWSAID=17878&group=politics
[43] Open Source Software in Finnish Education available at http://www.innopark.fi/attachments/OSS-whitepaper_eng21.doc

appear to be given choice and may use FOSS or proprietary software, including the software offered by Microsoft at no charge.

2.6.4.2 Microsoft Live@edu Services[44]

This section provides brief details of the Live@edu services offered by Microsoft to the Finnish education system. They comprise the following components:

- Email services provided through Windows Live Hotmail and Microsoft Exchange Laboratories;
- Collaboration services provided through Office Live Workspace, Live SkyDrive beta, SharedView beta and LiveSpaces; and
- Communication services through Live Messenger, Live Alert, and Mobile.

2.6.5 Further Research (Gartner)

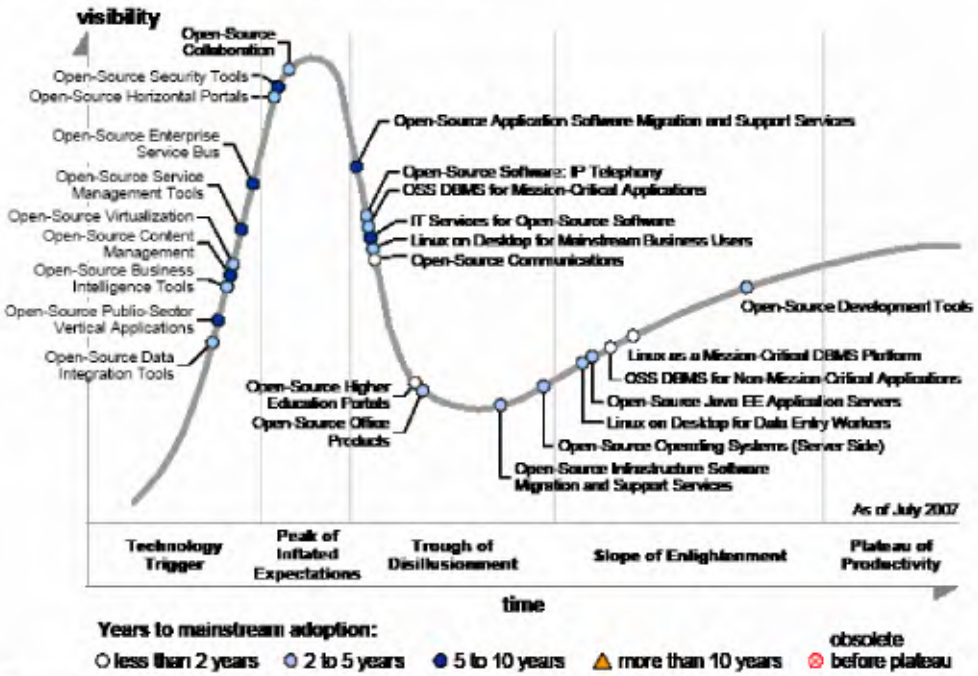
According to Gartner research:[45]

> Open-source software (OSS) continues to mature across a wide spectrum of market segments; however, the rate of maturity and the level of saturation vary from market to market. In some segments, open-source solutions rank among industry-leading products, but, in others, this model remains an option limited to aggressive technology adopters exclusively. Blended strategies that mix open source and closed source continue to dominate the majority of mainstream IT organizations.
>
> Mainstream OSS adoption patterns are changing in two ways. Open-source solutions are deployed in increasingly mission-critical scenarios where the service level must be equal to or better than closed-source alternatives, and open-source solutions are also being adopted by increasingly conservative IT organizations that regard cost and risk mitigation as their primary concerns. Hype Cycle positions reflect these patterns, because technologies emerging from the Trough of Disillusionment are best-suited to both challenges. This year, the Hype Cycle continues to show the relatively recent impact of open source broadly across mainstream IT market segments, with 72% of the technologies currently positioned prior to the Trough of Disillusionment; however, the Hype Cycle also shows that 56% of the technologies are measured with a maturity rating of 'adolescent' or better. This is further supported by aggressive maturity time frames because 72% of the technologies show 'time to plateau' metrics within five years.

[44] http://get.liveatedu.com/Education/Connect/Apps/

45 ID Number: G00148920 – 11 July 2007

Figure 1. Hype Cycle for Open-Source Software, 2007



Source: Gartner (July 2007)

2.6.6 Recommendation

In February 2007, the South African Government's Cabinet approved a FOSS policy,[46] which is supported by the establishment of a FOSS Programme Office with the following objectives:

- Coordinate all the FOSS work in Government;
- Create FOSS skills;
- Ensure that Government procurement is FOSS compliant;
- Ensure that MIOS and MISS are FOSS compliant; and
- Partner all FOSS migrations of Government departments starting with SITA's own FOSS migration.

Discussions were held with members of the FOSS Programme Office during the Due Diligence Phase, and it was determined that the overall migration strategy for Government is being finalized. A key consideration for this strategy is the interoperability of applications by the use of open standards as defined by the Minimum Interoperability Standards (MIOS). Based on this, the recommendation as per the Options Analysis is supported in that:

- A detailed assessment of FOSS applications, considering all the factors of cost, effectiveness, availability and support, needs to be performed;
- A detailed selective migration strategy and plan should be implemented over the indicative timeframes of the e-Education Initiative; and
- Such investigation and plan for the Department of Education be developed with the support and guidance of the FOSS Programme Office.

[46] http://www.info.gov.za/speeches/2007/07022211451001.htm.

Development of a selective migration strategy/plan should not be interpreted to mean that this Initiative should only consider the migration to FOSS once proprietary software solutions have been implemented or that all software should be either proprietary or FOSS. The above research has indicated that successes have already been achieved in certain FOSS areas, and that for the Initiative a hybrid of proprietary and FOSS will be applicable. This Initiative will not constitute a totally 'green fields' implementation, as there are certain areas where ICT has already been implemented using FOSS or where certain FOSS applications are already used by the Institution or by schools. However, there will be certain areas where ICT will be implemented for the first time. The selective migration strategy/plan should therefore address both areas where the benefits of FOSS could immediately be achieved, as well as areas where a migration, if applicable, is required from areas either where proprietary software has already been implemented or where it is more effective to first implement certain proprietary software and then migrate to FOSS at a later stage.

2.7 Output Specifications Relevant to ICT Infrastructure and Connectivity

Based on the Needs Analysis performed, various outputs were defined that the e-Education Initiative is required to achieve, which have a direct bearing on ICT infrastructure and connectivity. These were defined as:

Administrators, Manager, Educators, and Learners

- Affordable, sufficient, and scalable connectivity enables all schools and FET colleges to connect as many ICT devices as they require to the Internet, thus ensuring that any online activities (managerial, administrative, or educational) being undertaken by the school can be done reliably, quickly, and securely. A national 'backbone' network is used to facilitate affordable and scalable connectivity.
- Strategies are implemented that deliver affordable, sufficient, and scalable connectivity to school and FET colleges, harnessing an appropriate mix of telecommunications technologies, in an effort to balance delivery with cost-effectiveness. All technological choices made within this strategy make provisions for scalability as demand increases and for upgrading and replacement of technological options as new and more cost-effective choices become available, rather than locking school and FET colleges and the system into single technological choices for extended periods.

Administrators and Managers

- Every school and FET college has sufficient ICT infrastructure in place to enable it to use electronic administrative and management information systems.
- Fit-for-purpose, effective communication systems software is made available to all relevant personnel to facilitate effective electronic communication up and down the system.

Educators

- Online communities of practice are launched and effectively managed on an ongoing basis across all learning/areas and subjects, broken down by phase and/or grade level as appropriate.
- Online communities of practice are launched and effectively managed on an ongoing basis across all school and FET college programmes.

- Online communities of practice are actively marketed to all educators

Learners

- Learning Management Systems and the associated educational materials and management processes are established to support distance learning in specialized subjects.
- Fit-for-purpose, effective communication systems software is made available to all learners to facilitate their communication with peers and educators

The ICT infrastructure output specifications required to achieve the above-mentioned outputs are as follows:

Table 6 Output Specifications for ICT Infrastructure and Local Area Network

Requirement	Output Specifications
ICT infrastructure	• ICT Infrastructure for Administrators and Managers (See Table 6 - The functional requirements of ICT infrastructure)
	• ICT Infrastructure for Educators and Learners (See Table 6 - The functional requirements of ICT infrastructure)
	• 99.5 % availability of all ICT Infrastructure within core school hours
Local Area Network (LAN) / servers (i.e. mail, data, file and print servers, etc.)	• Connectivity from the LAN to the WAN (routers / switches)
	• Separate LAN for Administrators and Managers to access VPN (physical or virtual split – wired or wireless)
	• 1 Gbps link (Wired – CAT6 cabling / Fibre)
	• Separate LAN for Educators and Learners to access VPN (physical or virtual split – wired or wireless)
	• 1 Gbps link (Wired – CAT6 cabling / Fibre)
	• 99.5 % availability of LAN connectivity within core school hours
Other related services	• Authentication and identification of all users on the LANs (Administrators, Managers, Educators, and Learners)
	• Intrusion detection and prevention to all school LANs (from the WAN as well as internal)
	• Antivirus protection on all ICT Infrastructure, LANs and Servers
	• Daily back-up of all ICT Infrastructure, LANs and servers (full or incremental)
	• Uninterrupted power supply (UPS) for all critical ICT Infrastructure (i.e. Laptops, PC's, Printers, IT & CAT Labs), LANs (routers and switches) and Servers.
	• Provision of a help desk (call centre) for ICT Infrastructure and LAN related problems, available during core school hours (this should include support from all levels, i.e. supplier, school, district, and national.)
	• Resolution of ICT Infrastructure and LAN problems within agreed level of performance (i.e. Mean Time t o Repair = 2 hours)
	• Physical security of all ICT infrastructure - All windows secured with burglar bars - Soft ceilings should be secured with burglar bars - All doors secured with security gates - Alarms in all offices and ICT Labs - Access control to school grounds (fenced off with lockable gates during school and after hours) • All movable infrastructures to be secured to desks, etc. (i.e. cable

Requirement	Output Specifications
	lock for laptops / desktops, etc.)
	• Environmental controls - Air conditioning - Fire protection - Adequate power supply - Humidity protection
	• Adequate electricity supply to operate all ICT Infrastructure (Laptops, Desktops and Servers) and the LAN. This can be provided from the ESKOM Grid, Solar or Generator.
	• The following other services should also be included in the procurement requirements (whole lifecycle): - Warranty; - Insurance; - Upgrade; - Disposal

All of the above are subject to the Minimum Norms and Standards, Minimum Interoperability Standards (MIOS), and Minimum Information Security Standards (MISS) as issued by the Institution and / or Government and updated from time to time.

2.8 Solution Specifications for ICT Infrastructure

During the Due Diligence Phase, meetings were held with various role players of the Institution as well as representatives from SITA to obtain an understanding of the functional requirements and technical specifications for the solutions specified in the ICT infrastructure outlined above. The Institution does not have an approved ICT architecture model to guide future ICT developments and procurements, but is in the process of developing an IT strategy. It is thus important that an ICT architecture model be developed and included in the IT strategy to guide any future ICT developments. Additional documentation such as the Department of Education's *Norms and Standards for Schools ICT Hardware* and the *FET Specifications - V1.0(f) - 27 February 2008* were obtained to provide input as to the current specifications and requirements of the Department of Education regarding implementation of ICT infrastructure.

The Department of Education's *Norms and Standards for Schools ICT Hardware* defines minimum standards that should be used when ICT hardware is acquired either through existing SITA transversal contracts, new contracts or donor and refurbished equipment. The ICT hardware identified in this document consists of the following:

- Desktop PCs (computers);
- Notebooks (also known as, laptop computers);
- Printers; and
- Servers.

For these devices, a set of basic system configurations have been recommended to assist in acquisition of ICT hardware for a number of functional requirements. These requirements vary between configurations of a desktop PC for use in a CAT laboratory and IT laboratory, curriculum integration, and school administration. The document also provides guidance on configuration of educator laptop computers, printers, and server configuration.

In addition a breakdown of ICT hardware as defined in the current Seat Management Services contracts, RFT 285/1, RFT 153 and RFT431, between SITA and various suppliers, has been included in the DoE's *Norms and Standards for Schools ICT Hardware*. These include the following ICT hardware devices:

- Desktop PCs (computers);
- Notebooks (also known as laptop computers);
- Printers (personal printers, shared printers, and specialized printers);
- Multifunctional devices;
- Scanners;
- Cameras and presentation devices;
- Personal digital assistants (PDAs);
- Flat panel monitors; and
- Servers.

It should be noted that these specifications, as well those referred to in the Seat Management Services contracts, are subject to change as technology requirements and specifications continuously change as newer technology are made available on a regular basis. Given this, the technical standards used within this document should be used as a guide although the specifications themselves should be revisited at least annually to ensure that they conform to the latest market and technological offerings.

In contrast to the Norms and Standards document, the *FET Specifications - V1.0(f) - 27 February 2008* document is mostly concerned with defining hardware specifications for network infrastructure.

The requirements for ICT infrastructure detailed in the tables below are therefore an integration of both these standards and are the recommended specifications for the ICT solutions discussed above. Only the solution specifications for the ICT Infrastructure that will be provided as part of the 'push' strategy have been defined. This is mainly due to rapid rate at which specifications normally change and due to uncertainty regarding which ICT Infrastructure will be procured through the School ICT Development Plans.

Table 7 Functional requirements of ICT infrastructure

	Requirement	**Functional Profile**	**Typical Applications**	**Type of Infrastructure**
Educators and Learners	CAT Laboratory	Basic computer application training primarily on office applications	Basic office applications (e.g. Word processing, Spreadsheets, Presentations), e-mail, web browser	Managed Client PC / Laptop Multifunctional printing devices Basic Server
	IT Laboratory	Basic training in programming (4G language) including databases, web-pages, networks, etc.	More advanced applications (e.g. Programming Languages, Databases, etc.), e-mail, web browser Other training titles	Managed Client PC / Laptop Multifunction Printing Devices Basic Server

	Requirement	Functional Profile	Typical Applications	Type of Infrastructure
Administrators and Managers	School Administration	Day-to-day running of the school, including finances, communications, etc.	Office applications (e.g. Word processing, Spreadsheets, Presentations), e-mail, web browser, financial applications, institutional transversal systems (e.g. EMIS, SA SAMS, etc.)	Advanced PC Multifunction Printing Devices Basic Server
	Principals	Day-to-day running of the school, including finances, communications, etc.	Office applications (e.g. Word processing, Spreadsheets, Presentations), e-mail, web browser, financial applications, institutional transversal systems (e.g. SA SAMS)	Basic laptop Basic printer

As mentioned above, it is important to note that these specifications are notional only and will be used for pricing and value assessment purposes only. It is also important to note that this is not a complete list of all end-user devices, but rather only those that will be procured as part of the initial 'push' strategy of the implementation.

The Department of Education (national and provincial, in conjunction with the schools) will research all other ICT Infrastructure included in the Educational ICT Development Plans and issue solution specifications in the 'Department of Education's *Norms and Standards for Schools ICT Hardware*. Such norms and standards should also comply with the interoperability and security requirement standards (i.e. MIOS and MISS).

Table 8 Minimum specifications for ICT infrastructure

Item	Minimum Specifications
Advanced PC	3.2GHz Processor 512MB RAM Memory 160GB Hard drive 32MB graphics controller (integrated is acceptable) DVD-RW drive Network card (1000 Base T) USB ports LCD monitor (15" or 17") Operating System Internet Browser software E-mail client software
Basic laptop	1.7GHz Processor 512MB RAM Memory 40GB Hard drive DVD-RW drive Network card (1000 Base T) USB ports LCD monitor (15" or 17")

Item	Minimum Specifications
	Operating System Internet Browser software E-mail client software
Basic printer	20 ppm monochrome laser printer 250-page input tray Network card (1000 Base T)
Multifunction devices	Monochrome Printer/ Scanner/ Copier/ Fax combo (sheet-fed) 20 ppm monochrome laser printer 250-page input tray Network card (1000 Base T)
Managed client PC / Laptop	1GHz Processor 512MB RAM memory 40GB Hard drive Network card (1000 Base T) or WIFI adapter USB ports LCD Monitor (15" or 17") Operating System Internet Browser software E-mail client software
Basic server	3.2GHz Processor 1024MB RAM memory 160GB Hard drive DVD-RW drive Network card (1000 Base T) USB ports LCD monitor (15" or 17") Operating System Internet Browser software E-mail client / serve software

3 Model for Allocation of ICT Laboratories for Schools Offering CAT and IT

3.1 Introduction

Below, we present a model to project the number of ICT Labs required by schools to offer Computer Applications Technology (CAT) and/or Information Technology (IT) at FET level in schools. The model has been designed to allow for changes to be made to the variables, generating different results as each assumption is adjusted.

3.2 Model Assumptions

The following assumptions have informed construction of the model:

1) CAT and IT both require individual computer access for four hours per week in each of grades 10, 11, and 12.[47]
2) The ICT laboratory requirements will depend on the size of the school. The *Education Infrastructure Norms and Standards* document defines the following categories for size of schools:
   a) Multi-grade schools (<50 learners; 1 teacher);
   b) Multi-grade schools (51 - 100 learners; 2 to 3 teachers);
   c) Small schools (101 – 200); up to 7 teachers);
   d) Medium schools (201 – 500); up to 16 teachers);
   e) Medium/large schools (501 – 1000); up to 30 teachers);
   f) Large schools (1001 – 1500); up to 50 teachers);
   g) Super large schools (1501 +; 50 + teachers).
3) Because increased requirements for access to ICT laboratories is anticipated as learner enrolment in these subjects increase and as there is growing use of ICT in other subjects and learning areas, it is prudent to use the upper limit of the school size categories for planning purposes.
4) It has been assumed that average learner enrolments in CAT and IT are similar to the national proportion number of schools offering IT and CAT in the national system:

Table 9 Number of schools offering IT and CAT

EMIS 2007 data	Number	Percentage
Number of schools currently offering CAT	180	26%
Number of schools currently offering IT	448	66%
Number of schools currently offering IT and CAT	53	8%
Total	**681**	

Consequently, because individual learners cannot take both CAT and IT (but may opt to take either or neither), it has been assumed that on average at a typical school offering CAT or IT or both:

a) 50% of learners per grade will opt to take CAT; and

[47] Correspondence with C. Labuschagne, national Department of Education, on policy of IT and CAT computer access requirements, March 2008.

b) 20% of learners per grade will opt to take IT.

5) It is assumed that each ICT laboratory is available for lesson time use for 20 hours per week. This takes into account the need for the daily allocation of time for breaks, assemblies, transition time between lessons, and so on. This was the assumed school time capacity applied in the scenarios generated to calculate target learner:computer ratios for schools.
6) The average distribution of schools offering CAT and schools offering IT by school size has been used.

Table 10 Distribution of schools offering IT and CAT

	Multigrade <50	**Multigrade 51-100**	**Small school**	**Medium school**	**Medium/ large school**	**Large school**	**Super large school**
National distribution of schools by school size	8%	6%	12%	36%	29%	9%	1%
Average national distribution of schools offering CAT or IT by school size	1%	1%	3%	15%	44%	27%	6%

7) A key element in analysing ICT laboratory requirements is to understand the number of groups (or classes) in a grade that are enrolled for IT or CAT. This is a function of the class size. The *Education Infrastructure Norms and Standards* assumes 24 learners per group to define infrastructure requirements, but this seems low and in conflict with the current average learner:educator ratio of 32:1 per school, so we have assumed a maximum group size of 30.
8) Provision of ICT laboratories to support the curriculum requirements of CAT and IT is now part of the 'push' strategy of the e-Education Initiative, at the specific request of the Institution. It is expected that, over time, there will be increased demand for access to ICT laboratories in schools. ICT access is required for ICT integration across all learning areas at GET level, and for integration into most FET subjects (in addition to CAT and IT access requirements). Consequently, where the model results in more capacity being available than is required for IT and CAT only, this has not been adjusted. It is anticipated that this additional capacity will be used for ICT integration in other subject areas. As a result, this model rounds up to the nearest whole number when calculating the number of groups per grade and the number of ICT laboratories per school, wherever fractional allocations occur.
9) In 2007, 448 schools offering CAT and IT subjects report that they have a computer centre to do this (EMIS data 2007). Consequently, it has been assumed that these schools already each have one ICT laboratories that can accommodate 30 learners.

The above assumptions have been used to calculate the number of ICT laboratories for each school size. They were applied uniformly, except with the smallest categories of schools:

- Multigrade schools of fewer than 50 learners;
- Multigrade schools with between 51 and 100 learners; and
- Small schools with between 101 and 200 learners.

For these small schools it was assumed that a small school would only offer either CAT or IT and not both. The reason for this adjustment was that applying the generic assumption of 50% enrolment in CAT and 20% enrolment in IT to a small school resulted in very small group sizes for IT. As a result, a small school then required two ICT laboratories to manage both subject offerings. This was not thought to be economically justified as the school contributed only a very small number of IT learners. Instead, an assumption of 70% learner enrolment in CAT and 0% learner enrolment in IT was applied to small schools. This resulted in the more attainable objective of one ICT laboratories for a small school.

3.3 Results

The following presents a summary of the results of applying the assumptions within the model:

Table 11 Summary of results of IT and CAT laboratory distribution model

Assumptions	Multi grade <50	Multi grade 51-100	Small school	Medium school	Medium /large school	Large school	Super large school
Number of Learners (max)	50	100	200	500	1,000	1,500	2,000
Assumed proportion of learners taking CAT	70%	70%	70%	50%	50%	50%	50%
Assumed proportion of learners taking IT	0%	0%	0%	20%	20%	20%	20%
Total computer hours per week for CAT and IT	12	12	12	36	72	84	120
Assumed hours per week for laboratory use during school time	20	20	20	20	20	20	20
Number of computer laboratories required	**1**	**1**	**1**	**2**	**4**	**5**	**6**
Available hours per week for laboratory use during school time	20	20	20	40	80	100	120
Remaining hours per week for GET and other FET subjects	8	8	8	4	8	16	0

This data for each size of school may be adjusted to allow for the assumptions applied to be varied depending on the school size. The data applied for each school size is presented in detail below.

Using this summary of data, the implications for national rollout of ICT laboratories to support the curriculum requirements of CAT and IT are as follows:

Table 12 National rollout requirements for CAT and IT laboratories

	Multi grade <50	Multi grade 51-100	Small school	Medium school	Medium / large school	Large school	Super large school	Total
National distribution of schools by school size	8%	5%	12%	36%	29%	9%	1%	
Average national	1%	1%	3%	16%	45%	28%	6%	

	Multi grade <50	Multi grade 51-100	Small school	Medium school	Medium / large school	Large school	Super large school	Total
distribution of schools offering CAT or IT by school size								
Number of laboratories required for schools currently offering IT and/or CAT	6	6	18	184	1035	805	207	**2261**
Schools currently offering CAT or IT with an existing computer centre								448
Number of new laboratories required								**1813**

This results in a requirement for 1,813 new ICT laboratories for schools currently offering CAT and IT. This does not include new ICT laboratories required for schools which plan to offer CAT and IT, but have not yet done so.

If the model used to calculate computer laboratories required for CAT and IT was modified to provide only a single laboratory for each of the 681 schools offering either or both subjects, there would only be a need to provide 233 laboratories (as 448 of these schools already report having one laboratories).

However using this model, which takes into account the size of a school, 1,813 computer laboratories are required, applying the above assumptions. This is because multiple computer laboratories are required to cater for assumed learner enrolment levels in CAT and IT in large schools. There are also more computer laboratories needed in small (multigrade <50, Multigrade 51-100 and small) schools. In the multigrade schools of less than 100 learners, laboratories with a capacity for 20 learners (rather than the assumed 30 learners) can be implemented – but each multigrade school offering CAT or IT still requires a computer laboratory.

As a final note of caution, the assumptions made about learner enrolment levels for each size of school may not be realistic and still need to be compared with actual learner enrolment data.

4 Connectivity

4.1 Introduction

As part of the Due Diligence phase of this e-Education Initiative, the existing connectivity of provincial Departments of Education and FET Colleges and viability of the connectivity options recommended during the Option Analysis were discussed with various representatives from the Institution and SITA. As a result, the connectivity model was updated to provide additional detail, as well as to indicate the FET College connectivity model.

4.2 Connectivity Due Diligence Considerations

During the Due Diligence assessment of the recommended connectivity model as detailed in the Options Analysis, we have concluded that only the WAN Backbone connectivity option required further investigation. Therefore the 'Last Mile' and Local Area Network (LAN) options remain unchanged and are not reviewed further in this report.

The two major reasons for the re-evaluation of the WAN Backbone options are the completion of the Next Generation Network (NGN) for Government and implementation of the FET College connectivity model.

4.2.1 Next Generation Network (NGN)

The following are extracts from announcements by the then Minister of Public Service and Administration (Minister Geraldine Fraser-Moleketi) on successful deployment of the NGN:[48]

> The State Information Technology Agency (SITA) today announced that together with its partners, Neotel and Business Connexion, it has successfully deployed a Next Generation Network (NGN) for the South African government. The NGN, a state-of-the-art network, replaces the Government Common Core Network (GCCN), which was first deployed in 2003.
>
> The NGN project was undertaken to address this constraint and with its deployment, SITA can now utilize the network's additional capacity to create more virtual private networks, cater for additional ports to connect clients and provide broadband solutions.
>
> Neotel, the country's second national telecommunications operator, was awarded a five year contract to provide national backbone transmission services to support the new NGN. Neotel's high capacity links connect SITA's key sites in major cities and towns across South Africa with nearly 700 Megabit per second of transmission bandwidth. This is nearly twice the bandwidth SITA has procured in the past.
>
> Subsequent phases of the NGN will entail the installation of dual routers into 10 of SITA's switching centres, which will commence in May 2008. Intrusion Prevention Devices will also be installed at customer sites, which are expected to commence around July 2008.

Based on the above announcement and discussions with technology architecture representatives from SITA, completion of the NGN enables SITA to provide VPN connectivity solutions to its client to improve management of connectivity options and usage.

[48] State and Partners successfully deploy Next Generation Network (05/02/2008)

4.2.2 Current FET College Connectivity Model

FET Colleges have been investigating connectivity options for much longer than the current e-Education Initiative, and therefore have already tested various options. There are two distinct characteristics that FET Colleges have exploited in their connectivity model.

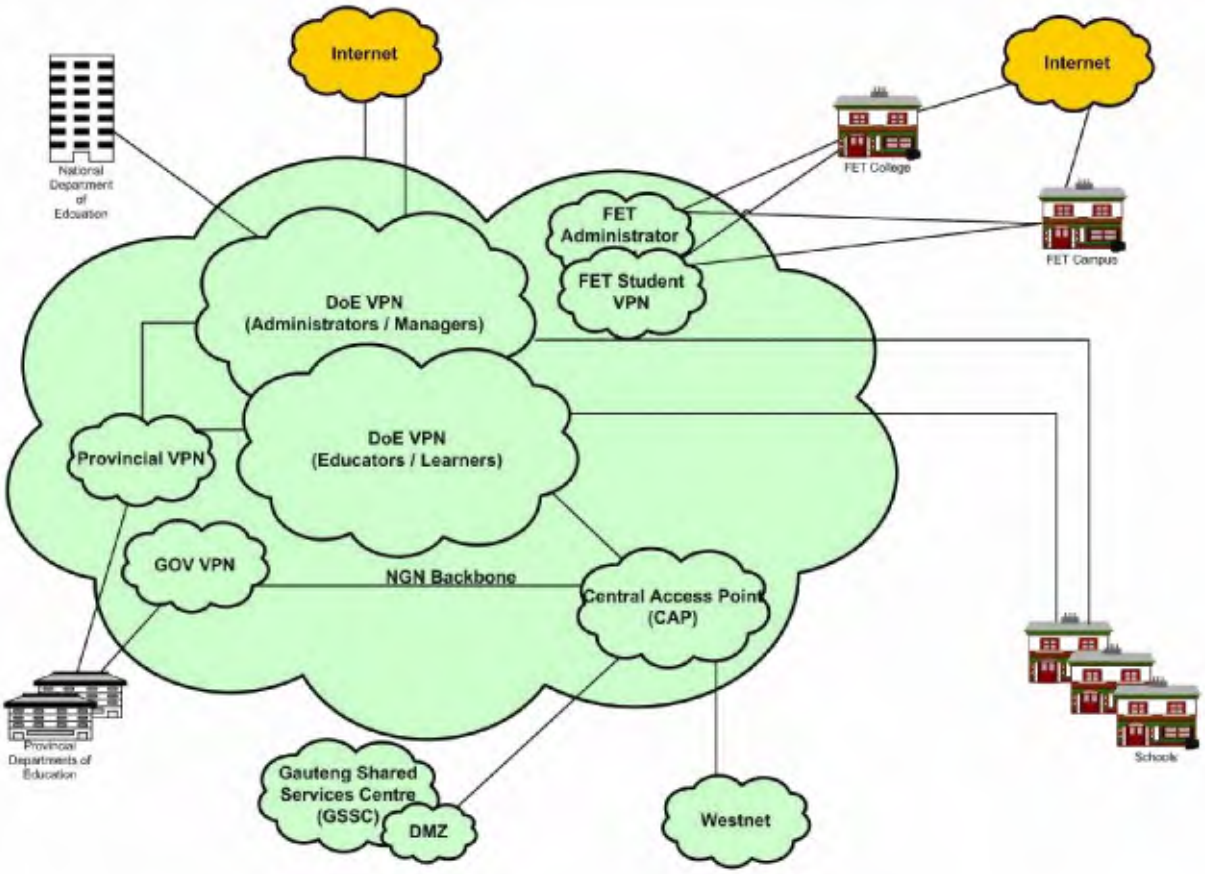
The first is use of different VPNs to separate administration and student-related traffic. This is done mainly for security reasons, as well as to be able to prioritize these types of traffic as required. (This was also included as a recommended option in the options analysis).

The second is to use a three-tier connectivity structure instead of a four-tier structure. The FET college structure consists of multiple campuses that function under the governance of one college. One could therefore expect that each campus will connect to the VPN via the college. This scenario ('hub and spoke) will therefore create a four-tier network structure for campuses, which will not only require the last-mile connection from the college to the VPN to be bigger, congestion caused by the one also affects the others that connect through the 'hub'.

Detail costing analysis performed by SITA has indicated that the connectivity cost of the three tier model is approximately 30% cheaper than the four tier model.

4.2.3 Recommended Connectivity Model for Schools

Given the above, the recommended connectivity option for schools is to create two separate dedicated education VPNs within the NGN (one for Administrator/Management traffic and one for Educator/Learner traffic) to which all schools connect via the 'last mile' connectivity option most suitable for their conditions and needs (bandwidth requirement).



Section 2.7 above outlined output specifications relevant to ICT infrastructure and connectivity, drawn from the Needs Analysis. The connectivity output specifications required to achieve the above-mentioned outputs are as follows:

Table 13 Output Specifications for connectivity

Requirement	Output Specifications
WAN Backbone / VPN	• WAN backbone connectivity per school (which is scalable as may be required) • Maximum latency of 150 milliseconds • Separate VPN for Administrators and Managers (to access institutional and transversal systems) • Separate VPN for Educators and Learners (to access the Internet and educational content portals) • Internet access to all schools (including facility to manage / block access to undesirable sites and filtering of content as may be required) • E-mail services (accounts) to all users (Administrators, Managers, Educators, and Learners)
'Last Mile' connectivity	• Connectivity of all school LANs to the WAN Backbone (which is scalable as may be required)

4.3 Solution Specifications

The solution specification was compiled using a combination of the FET College and Schools Norms and Standards, as well as through discussion with SITA technical personnel. This is a long-

term solution, which will require significant investment from the Institution. Therefore the ICT infrastructure, especially the type and capacity of the connectivity infrastructure, should provide a good return on investment.

To enable a good return on investment, the connectivity solution being designed and implemented should be developed with these longer term needs in mind and therefore should already cater for VOIP (voice over IP) and Video Streaming and for at least the capacity requirement for the next ten years. This requirement will be defined in detail the costing model for this Feasibility Study.

4.3.1 Wide Area Network (WAN Backbone) / Last Mile

4.3.1.1 Bandwidth Requirements Guideline

Due to the high number of systems being deployed inside networks, it is important to provide the necessary bandwidth to the systems to ensure overall performance. The following guidelines should be followed to determine bandwidth requirement per site as well as the core based on the number of workstations accessing the applications, and to determine correct application placement inside the network.

Application Requirements
To calculate the bandwidth requirements of a site, one need to perform an impact study and traffic flow analysis per application required. The following should be used as a baseline only:
12 Kbps – Internet, e-Mail, and Active directory
24 Kbps – Terminal server applications
64 Kbps – Data
364 Kbps - Voice

Over-subscription
The term "over-subscription" means that when calculating bandwidth requirements, one should not just calculate each user's requirements and multiply it by the number of users. To ensure that the bandwidth requirements are not over-subscribed, it is good practice to apply a factor to the calculation model for 1) the percentage of people that will not be in the office or school, and 2) the percentage of concurrent users at any given point in time. The following are recommended factors used by SITA when determining bandwidth requirements:

1) *Percentage of people in office / school - Remote Sites (Last Mile)*
   The over-subscription ratio from remote site to distribution layer is calculated as the total of workstations and applications to be accessed divide by 66.67% (assuming that a third of people will not be using their machines at any given time). For example:
   100 Workstation x 8 Kbps = 800 Kbps X 0.6667 = 533 Kbps or 512 Kbps
2) *Percentage of concurrent users - Core (WAN Backbone)*
   The over-subscription ratio from Core to Core is 4:1. Thus, it is calculated as total of site to distribution layer bandwidth divided by 4 (% of concurrent users). For example:
   100Mbs site to distribution / 4 = 25Mbs bandwidth at the core.

General
Any addition of new workstations to a LAN will have a direct influence on the bandwidth allocated and therefore capacity planning needs to be a vital part of the planning phase. Any new LANs or sites added to the network will have a direct influence on the remote site and core bandwidth and will thus have to be incorporated as part of the planning process to revisit the capacity planning of the core.

Most schools, that currently have links to the Internet, are linked through external service providers. Once schools are linked to the NGN, all external links should be discouraged, unless this is obtained for stand-alone PCs. This is also in line with the MISS requirements and SITA's policy to not allow unprotected external links to the NGN.

4.3.1.2 e-Rate

Where service providers are requested through the approved tender processes to provide pricing for educational purposes, such pricing must reflect a social responsibility discount as stipulated in the Electronic Communications Act 2005 (Act no 36 of 2005) in terms of the e-rate for the FET Colleges.

4.3.2 Local Area Network (LAN)

The local area network will be divided to provide separate network connectivity for Administrators and Managers and for that of Educator and Learners. This is mainly for security reasons and can be done through physical or virtual separation.

Detailed below are different options for each element of the LAN as defined in the Department of Education's *Norms and Standards for Schools ICT Hardware*' and the *FET Specifications - V1.0(f) - 27 February 2008*.

As mentioned above, it is important to note that these specifications are notional and will be used for pricing and value assessment purposes only. It is also important to note that this is not a complete list of all end-user devices, but rather only those will be procured as part of the initial 'push' strategy of the implementation.

Brand names have generally been excluded from this document, however, in this section the brand names have been included as they have been defined in the Norms and Standards documents for clarification of specifications during the procurement phase only.

The number of switches to be procured is dependent on the number and location of cabling points and fibre runs.

Table 14 Switches (CISCO power over Ethernet – 24 and 48 Port Switches)

Cisco Catalyst Switches – Power over Ethernet (24/48 Port)	
Item Name	**Description/Configuration**
WS-C3560G-24PS-E	Catalyst 3560 24 10/100/1000T PoE + 4 SFP Enhanced Image
WS-C3560G-48PS-E	Catalyst 3560 48 10/100/1000T PoE + 4 SFP Enhanced Image
WS-C3750G-24PS-E	Catalyst 3750 24 10/100/1000T PoE + 4 SFP Enhanced Image
WS-C3750G-48PS-E	Catalyst 3750 48 10/100/1000T PoE + 4 SFP Enhanced Image
WS-C3750G-12S-E GLC-SX-MM	Catalyst 3750 12 SFP Enhanced Multilayer Image GE SFP, LC Connector SX Transceiver

Table 15 Routers (CISCO 2821)

Part No	**Description/Configuration**

Part No	Description/Configuration
CISCO2821	2821 w/ AC PWR,2GE,4HWICs,3PVDM,1NME-X,2AIM,IP BASE,64F/256D
WIC-1T	1-Port Serial WAN Interface Card
CAB-X21MT	X.21 Cable, DTE, Male, 10 Feet

Table 16 Cabling / Fibre (for 1 Gb speed)

Description
Minimum CAT6
Multimode fibre up to 500 m
Single mode fibre after 500 m

Table 17 Switch Cabinets

Part No	Description/Configuration
MC05	25U x 19' x 800mm Complete floor standing Cabinet with Fans & Power
Mount kit	Mounting Kits
Raw8	Rawbolts 8mm
1RT-F4	450mm Frontmount Tray 19'

Table 18 Lightning Protection

Part No	Description/Configuration
Phase 1: Power Distribution Box (DB Box)	
NLFLASHTRB	Flash trab FLT60-400 (2 units needed for fase-1 protection)
Phase 2 (a): Router connection to Data Line in Environmental Cabinet	
NLVALEPLUG	Valetrab - plug VLA-MS 230 ST (2 units needed for fase-2 protection)
NLPROCHS-2U	Sparc trap equipment power (Including V11/X.21 interface & leased line protection)
Phase 2(b): Wall-mounted Switch Cabinet	
NLVALEBASE	Valetrab - base VLA-MS 230 BE/FM (2 units needed for fase-2 protection)
NLPROCHS-2U	Sparc trap equipment power (Excluding V11/X.21 interface & leased line protection)
	Installation for Lightning Protection

APC Smart-UPS 3000VA is the perfect UPS for protecting business critical workstations, network switches, and routers. With included PowerChute management software for servers and workstations, IT administrators can provide safe system shutdown and advanced UPS management (and all major operating systems are supported). Connectivity is provided through either serial or USB ports. Additional manageability is available through the SmartSlot, an internal accessory slot that allows the user to install optional accessories to enhance performance of the UPS. With pure sine-wave output ensuring compatibility with all connected devices, Intelligent Battery Management ensures a highly available UPS and an advanced 16 segment bar graph display ensuring information and management.

Table 19 Uninterrupted Power Supplies (UPS)

Item Name	Description/Configuration
Backup/Run Time	5.5 Minute(s) 2700W Full-load 13.6 Minute(s) 1350W Half-load

The Cisco ASA 5500 Series SSL/IPsec VPN Edition provides the flexibility required for any VPN deployment. The Cisco SSL VPN solution is easy to deploy and simple to use, offering both client and clientless options. It solves the unique challenges associated with diverse user groups and endpoints accessing the enterprise network, by offering granular access controls, depending on the user or endpoint. The Cisco ASA provides for the termination of IPSec and SSL tunnels and will be used to connect the schools to the different Virtual Private Networks.

Table 20 Security / Continuity: Cisco ASA

Description
ASA 5520 Appliance with SW, HA, 4GE+1FE, 3DES/AES
ASA 5510 VPN Edition w/ 250 SSL User License, 3DES/AES

The overall solution consists of three high-level components:

Table 21 Antivirus solution

Type of Symantec Solution Set	Description
a) Protection Symantec Enterprise Protection (SEP) v11 is compulsory.	This component protects the workstations and servers from malicious software and other malicious attacks prevalent in a networked computer environment. This component is provided in the form of the Symantec Enterprise Protection (SEP) software.
b) Management To manage the Antivirus agents, Altiris would be compulsory	This component provides capabilities such as hardware and software inventory, patch management, software delivery and client deployment capabilities. It is required to effectively manage a computer environment with the minimum resources. This is provided in the form of the Symantec Altiris suite of products.
c) Data availability The Net Backup and Backup Exec for data availability.	This component ensures that data stored on servers are protected from failure of hardware or other means and is recoverable in event of loss. This component is provided in the form of Symantec NetBackup PureDisk.

Tape storage devices are required to back-up critical data files, documents, and so on. Although most applications data will reside centrally at the national office, it is important that critical data residing at the school is identified and properly backed up on a daily basis.

Various sizes of tapes and tape drives are available, and therefore the size could range from small schools to very big schools.

Table 22 Tape Storage devices (Back-up)

	SDLT 220	**SDLT 320**	**SDLT 640**	**SDLT 1280**	**SDLT 2400**
Native Capacity	110GB	160GB	320GB	640GB	1.2TB
Compressed Capacity (2:1 compression)	220GB	320GB	640GB	1.28TB	2.4TB
Native DTR	11MBps	16MBps	32MBps	50+MBps	100+MBps
Compressed DTR	22MBps	32MBps	64MBps	100+MBps	200+MBps
Media	SDLT I	SDLT I	SDLT II	SDLT III	SDLT IV

4.3.2.1 Summary per Site Category

The table below sets out the recommended solution specifications for connectivity.

Table 23 Solution specification for connectivity

MICRO SITE (i.e. very small school)	
Description	**Requirement**
Router	2821 w/ AC PWR,2GE,4HWICs,3PVDM,1NME-X,2AIM,IP BASE,64F/256D
Switch	Catalyst 3560 24 10/100/1000T PoE + 4 SFP Enhanced Image
Data Line	128 Kbps
Cabling	Cat6
Environmental Cabinet	None
Switch Cabinet	25U x 19' x 800mm Complete floorstanding Cabinet with Fans & Power
Lightning Protection:	Phases 1, 2(a) and 2(b)
UPS	APC Smart-UPS 3000VA
Security	ASA 5520 Appliance with SW, HA, 4GE+1FE, 3DES/AES ASA 5510 VPN Edition w/ 250 SSL User License, 3DES/AES
Antivirus	Symantec Enterprise Protection (SEP) v11 is compulsory To manage the Antivirus agents, Altiris would be compulsory
Back-up / Recovery	Tape Storage device Symantec NetBackup PureDisk
Servers	None
Workstations:	Admin & Student (depending on requirement)
SMALL SITE (i.e. small school)	
Description	**Requirement**
Router	2821 w/ AC PWR,2GE,4HWICs,3PVDM,1NME-X,2AIM,IP BASE,64F/256D
Switch	Catalyst 3560 48 10/100/1000T PoE + 4 SFP Enhanced Image
Data Line	192K
Cabling	Cat5E
Environmental Cabinet	Single
Switch Cabinet	25U x 19' x 800mm Complete floorstanding Cabinet with Fans & Power (specifications depending on number of switches and servers required)
Lightning Protection	Phases 1, 2(a) and 2(b)
UPS	APC Smart-UPS 3000VA
Servers	Exchange Server (Cluster); Domain Controller Server (quantities depending on number of Admin and Student Users)
Workstations	Admin & Student (depending on requirement)
INTERMEDIATE SITE (i.e. medium school)	
Description	**Requirement**
Router	2821 w/ AC PWR,2GE,4HWICs,3PVDM,1NME-X,2AIM,IP BASE,64F/256D
Switch	Catalyst 3560 48 10/100/1000T PoE + 4 SFP Enhanced Image and Catalyst 3750 48 10/100/1000T PoE + 4 SFP Enhanced Image (depending on the number and location of cabling points and fibre runs)
Data Line	256K
Cabling	Cat5E
Environmental Cabinet	Single
Switch Cabinet	25U x 19' x 800mm Complete floorstanding Cabinet with Fans & Power (depending on number of switches and servers required)
Lightning Protection	Phases 1, 2(a) and 2(b)

UPS	APC Smart-UPS 3000VA
Servers	Exchange Server (non-Cluster); Domain Controller Server, Anti-Virus/ WUS/DHCP Server (quantities depending on number of Admin and Student Users)
Workstations	Admin & Student (depending on requirement)
MEDIUM SITE (i.e. medium to big school)	
Description	**Requirement**
Router	2821 w/ AC PWR,2GE,4HWICs,3PVDM,1NME-X,2AIM,IP BASE,64F/256D (depending on load a higher specification ie 2851 may be required)
Switch	Catalyst 3560 48 10/100/1000T PoE + 4 SFP Enhanced Image and Catalyst 3750 48 10/100/1000T PoE + 4 SFP Enhanced Image (depending on the number and location of cabling points and fibre runs)
Data Line	640K
Cabling	Cat5E
Environmental Cabinet	Double
Switch Cabinet	25U x 19' x 800mm Complete floorstanding Cabinet with Fans & Power (depending on number of switches and servers required)
Lightning Protection	Phases 1, 2(a) and 2(b)
UPS	APC Smart-UPS 3000VA
Servers	Exchange Server (non-Cluster); Domain Controller Server, Anti-Virus/ WUS/DHCP Server (quantities depending on number of Admin and Student Users)
Workstations	Admin & Student (depending on requirement)
MODERATE SITE (i.e. big school)	
Description	**Requirement**
Router	2821 w/ AC PWR,2GE,4HWICs,3PVDM,1NME-X,2AIM,IP BASE,64F/256D (depending on load a higher specification ie 3825 may be required)
Switch	Catalyst 3560 48 10/100/1000T PoE + 4 SFP Enhanced Image and Catalyst 3750 48 10/100/1000T PoE + 4 SFP Enhanced Image (depending on the number and location of cabling points and fibre runs)
Data Line	1408K
Cabling	Cat5E
Environmental Cabinet	Double
Switch Cabinet	25U x 19' x 800mm Complete floorstanding Cabinet with Fans & Power (depending on number of switches and servers required)
Lightning Protection	Phases 1, 2(a) and 2(b)
UPS	APC Smart-UPS 3000VA
Servers	Exchange Server (non-Cluster); Domain Controller Server, Anti-Virus/ WUS/DHCP Server (quantities depending on number of Admin and Student Users)
Workstations	Admin & Student (depending on requirement)
LARGE SITE (i.e. big to very big school)	
Description	**Requirement**
Router	2821 w/ AC PWR,2GE,4HWICs,3PVDM,1NME-X,2AIM,IP BASE,64F/256D (depending on load a higher specification ie 3825 may be required)
Switch	Catalyst 3560 48 10/100/1000T PoE + 4 SFP Enhanced Image and Catalyst 3750 48 10/100/1000T PoE + 4 SFP Enhanced Image (depending on the number and location of cabling points and fibre runs)
Data Line	1536K and higher
Cabling	Cat5E

Environmental Cabinet	Double
Switch Cabinet	25U x 19' x 800mm Complete floorstanding Cabinet with Fans & Power (depending on number of switches and servers required)
Lightning Protection	Phases 1, 2(a) and 2(b)
UPS	APC Smart-UPS 3000VA
Servers	Exchange Server (non-Cluster); Domain Controller Server, Anti-Virus/ WUS/DHCP Server (quantities depending on number of Admin and Student Users)
Workstations	Admin & Student (depending on requirement)

Annexure A: Models for Allocation of Computer Laboratories for Schools Offering CAT and IT

Multigrade school (<50)l

Assumptions

Number of Learners (max)	50
Number of educators	
Assumed upper limits of number of learners per grade	10
Assumed upper limit of class size	15
Assumed upper limit of number of groups per grade	1

	Percentage	Per grade					Total Grades 8-12
Computer Application Technology		**8**	**9**	**10**	**11**	**12**	
Assumed proportion of learners taking CAT	70%	0	0	7	7	7	**21**
Number of groups taking CAT		0	0	1	1	1	**3**
CAT hours per week requiring individual computer access per grade				4	4	4	**12**
Information Technology							
Assumed proportion of learners taking IT	0%	0	0	0	0	0	**0**
Number of groups taking IT		0	0	0	0	0	**0**
IT hours per week requiring individual computer access per grade				0	0	0	**0**

Total computer hours per week for CAT and IT	12
Assumed hours per week for lab use during school time	20
Number of computer labs required	**1**
Available hours per week for lab use during school time	20
Remaining hours per week for GET and other FET subjects	8

Notes:
The lab in this scenario could be for 20 learners and not 30 learners as for other labs

Multigrade school (51-100)

Assumptions

Number of Learners (max)	100
Number of educators	
Assumed upper limits of number of learners per grade	20
Assumed upper limit of class size	20
Assumed upper limit of number of groups per grade	1

	Percentage	**Number of learners per grade**					**Total Grades 8-12**
Computer Application Technology		**8**	**9**	**10**	**11**	**12**	
Assumed proportion of learners taking CAT	70%	0	0	14	14	14	**42**
Number of groups taking CAT		0	0	1	1	1	**3**
CAT hours per week requiring individual computer access per grade		0	0	4	4	4	**12**
Information Technology							
Assumed proportion of learners taking IT	0%	0	0	0	0	0	**0**
Number of groups taking IT		0	0	0	0	0	**0**
IT hours per week requiring individual computer access per grade		0	0	0	0	0	**0**

Total computer hours per week for CAT and IT	12
Assumed hours per week for lab use during school time	20
Number of computer labs required	**1**
Available hours per week for lab use during school time	20
Remaining hours per week for GET and other FET subjects	8

Notes:
The lab in this scenario could be for 20 learners and not 30 learners as for other labs

Small secondary school

Assumptions

Number of Learners (max)	200
Number of educators	7
Assumed upper limits of number of learners per grade	40
Assumed upper limit of class size	30
Assumed upper limit of number of groups per grade	2

	Percentage	**Number of learners per grade**					**Total Grades 8-12**
Computer Application Technology		**8**	**9**	**10**	**11**	**12**	
Assumed proportion of learners taking CAT	70%	0	0	28	28	28	**84**
Number of groups taking CAT		0	0	1	1	1	**3**
CAT hours per week requiring individual computer access per grade		0	0	4	4	4	**12**
Information Technology							
Assumed proportion of learners taking IT	0%	0	0	0	0	0	**0**
Number of groups taking IT		0	0	0	0	0	**0**
IT hours per week requiring individual computer access per grade		0	0	0	0	0	**0**

Total computer hours per week for CAT and IT	12
Assumed hours per week for lab use during school time	20
Number of computer labs required	**1**
Available hours per week for lab use during school time	20
Remaining hours per week for GET and other FET subjects	8

Medium secondary school

Assumptions

Number of Learners (max)	500
Number of educators	16
Assumed upper limits of number of learners per grade	100
Assumed upper limit of class size	30
Assumed upper limit of number of groups per grade	4

	Percentage	**Number of learners per grade**					**Total Grades 8-12**
Computer Application Technology		**8**	**9**	**10**	**11**	**12**	
Assumed proportion of learners taking CAT	50%	0	0	50	50	50	**150**
Number of groups taking CAT		0	0	2	2	2	**6**
CAT hours per week requiring individual computer access per grade				8	8	8	**24**
Information Technology							
Assumed proportion of learners taking IT	20%	0	0	20	20	20	**60**
Number of groups taking IT		0	0	1	1	1	**3**
IT hours per week requiring individual computer access per grade		0	0	4	4	4	**12**

Total computer hours per week for CAT and IT	36
Assumed hours per week for lab use during school time	20
Number of computer labs required	**2**
Available hours per week for lab use during school time	40
Remaining hours per week for GET and other FET subjects	4

Medium/large secondary school

Assumptions

Number of Learners (max)	1000
Number of educators	30
Assumed upper limits of number of learners per grade	200
Assumed upper limit of class size	30
Assumed upper limit of number of groups per grade	7

	Percentage	**Number of learners per grade**					**Total Grades 8-12**
Computer Application Technology		**8**	**9**	**10**	**11**	**12**	
Assumed proportion of learners taking CAT	50%	0	0	100	100	100	**300**
Number of groups taking CAT		0	0	4	4	4	**12**
CAT hours per week requiring individual computer access per grade		0	0	16	16	16	**48**
Information Technology							
Assumed proportion of learners taking IT	20%	0	0	40	40	40	**120**
Number of groups taking IT		0	0	2	2	2	**6**
IT hours per week requiring individual computer access per grade		0	0	8	8	8	**24**

Total computer hours per week for CAT and IT	72
Assumed hours per week for lab use during school time	20
Number of computer labs required	**4**
Available hours per week for lab use during school time	80
Remaining hours per week for GET and other FET subjects	8

Large secondary school

Assumptions

Number of Learners (max)	1500
Number of educators	30
Assumed upper limits of number of learners per grade	300
Assumed upper limit of class size	30
Assumed upper limit of number of groups per grade	10

	Percentage	**Number of learners per grade**					
Computer Application Technology		**8**	**9**	**10**	**11**	**12**	**Total Grades 8-12**
Assumed proportion of learners taking CAT	50%	0	0	150	150	150	**450**
Number of groups taking CAT		0	0	5	5	5	**15**
CAT hours per week requiring individual computer access per grade		0	0	20	20	20	**60**
Information Technology							
Assumed proportion of learners taking IT	20%	0	0	60	60	60	**180**
Number of groups taking IT		0	0	2	2	2	**6**
IT hours per week requiring individual computer access per grade		0	0	8	8	8	**24**

Total computer hours per week for CAT and IT	84
Assumed hours per week for lab use during school time	20
Number of computer labs required	**5**
Available hours per week for lab use during school time	100
Remaining hours per week for GET and other FET subjects	16

Super large secondary school

Assumptions

Number of Learners is 1500+, assumed max:	2000
Number of educators	30
Assumed upper limits of number of learners per grade	400
Assumed upper limit of class size	30
Assumed upper limit of number of groups per grade	14

	Percentage	**Number of learners per grade**					
Computer Application Technology		**8**	**9**	**10**	**11**	**12**	**Total Grades 8-12**
Assumed proportion of learners taking CAT	50%	0	0	200	200	200	**600**
Number of groups taking CAT		0	0	7	7	7	**21**
CAT hours per week requiring individual computer access per grade		0	0	28	28	28	**84**
Information Technology							
Assumed proportion of learners taking IT	20%	0	0	80	80	80	**240**
Number of groups taking IT		0	0	3	3	3	**9**
IT hours per week requiring individual computer access per grade		0	0	12	12	12	**36**

Total computer hours per week for CAT and IT	120
Assumed hours per week for lab use during school time	20
Number of computer labs required	**6**
Available hours per week for lab use during school time	120
Remaining hours per week for GET and other FET subjects	0

Annexure B: Legal Due Diligence Report