Open Education

http://www.apoplous.org | Newsletter # 7 | April 2006 |

The Cost of Thin Clients

We have been working with Thin Clients in Primary Education for the past two years. What started in one school now has expanded to 4, with prospects of including even more schools by next year.

Our research has also caught the attention of the private sector as well as the Greek Ministry of Education and Religion. However, one question remains: are Thin Clients really an inexpensive solution compared to the ever-decreasing price of normal 'Fat' PCs? Furthermore, is it worth it to move away from a multimedia- ready PC (that includes 3D graphics support, CD/DVD etc) for a very simple machine that runs from the network? Obviously, Thin Clients are not the right choice for everyone. We investigate the Total Cost of Ownership, and we reach a (safe) conclusion.
(Continued p.2)

In this issue:

Contact Information:
Alexandros Kofteros
13 Pindou Str., Flat 203,
2035 Strovolos,
Nicosia, Cyprus

alexandros@apoplous.org

www.apoplous.org

'apoplous' newsletter created on a PowerMac G5 using inDesign CS suite.

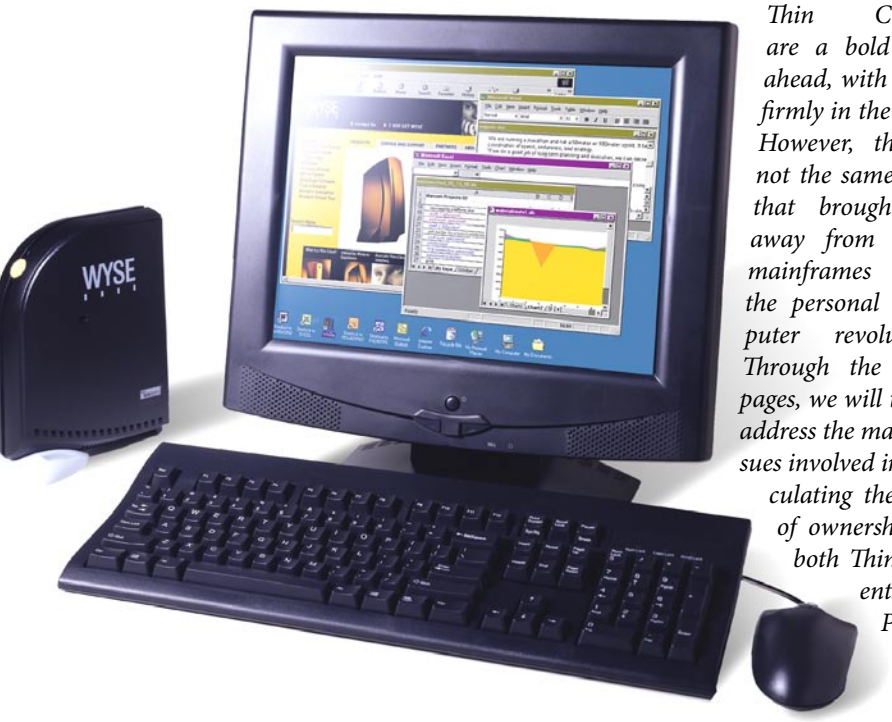
Interactive Whiteboards: Necessity or Luxury?

The question is more academic than real. Our experience so far with an interactive whiteboard kindly donated by SMARTtech and Achelec has shown us the true potential of this technology. Within few days of use we have seen students from the entire school wanting to work on the board. Even students that are quite shy (even though not necessarily with low grades), expressed their interest to come on board to either demonstrate an example or solve a problem altogether. Of course, an interactive whiteboard is not just that -a board- but the sum of all its parts. Therefore, we try to examine the various accessories that come with the board, including markers, eraser and software.

What is most striking is the actual content provided with the board- an amazing array of clipart that covers most subjects in vector format. This is a two-part presentation of the technology, as SMARTtech has officially included 'apoplous' as part of their beta testers of SMARTideas software for the Linux platform. (p.18)

The Cost of Thin Clients

With the price of normal PCs going down on an almost daily basis, can Thin Clients -that can cost even twice as much as a PC- pose a viable solution for education? We investigate the actual costs involved.



Thin Clients are a bold step ahead, with roots firmly in the past. However, this is not the same past that brought us away from large mainframes into the personal computer revolution. Through the next pages, we will try to address the main issues involved in calculating the cost of ownership of both Thin Clients and PCs.

Why Thin Clients?

Personal Computers have reached an acceptable price point for most (developed) countries. Individually they are quite acceptable for our everyday needs. When we use them in large numbers, however, their cost tends to escalate with continuous use.

What the Ministry of Education in Cyprus has done so far, is establish at least one Intel/Windows based PC in every single classroom across Cyprus- a number of more than 5 000 clients. The main problem arises with the fact that no single IT person exists to take care the maintenance of these machines. Teachers work full time with their normal duties, and out of 35 periods of each week, they work (up to the 12th year of their service) for 29 periods. As such, teachers at school can (and will not, by decision of the Teachers Union) not do maintenance work on the machines.

Even though all machines (upon purchase) are covered by a guarantee, this doesn't not include maintenance made for software issues (ie accidentally removing vital files or flooding the computer with unnecessary and even unwanted files and applications.

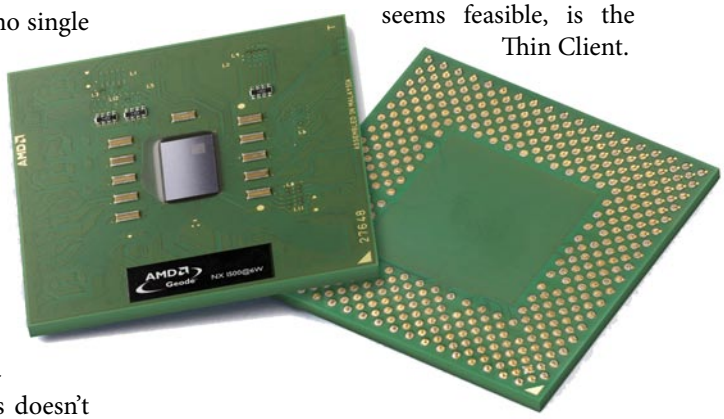
Every time a PC malfunctions, the company responsible for its maintenance is called. From the moment of call until the actual arrival of the technician, a small to significant amount of time will pass. If the problem is hardware - and the machine is covered by the guarantee- then this will cost nothing in terms of components or labor. However, if the problem is hard-drive based, then most probably all data will be lost!

Anyone working with computers knows that, for a 5-year+ cycle, maintenance is a serious issue. Even if the hardware (or the software) does not cause any major problems, there are still issues of updates, upgrades and normal (software) maintenance work to be done.

Other factors that are against using normal ('Fat') PCs in the classroom are the actual size of the machine, the power consumption, the level of noise, the heat generated by it, as well as the obvious threat of theft (something that, unfortunately, is becoming quite common).

From 1 to 3 clients

The problems mentioned above will be made even worst with the move from 1 client per classroom to 3 clients per classroom. We believe, however, that for IT to work successfully and to help us achieve whole class learning, a more drastic approach of at least a 1 client per desk should be applied. The only solution -at this point- that seems feasible, is the Thin Client.



Fat Vs Thin: Power Consumption

Our world today faces a major crisis: our energy reserves are low, while the oil prices are skyrocketing. As such, all our devices must become more power-conscious. We take a look at power consumption.

A significant cost, that of power consumption, is often overlooked when deciding the purchase of computer equipment. However, this is a significant feature of each computer and should be taken into serious consideration.

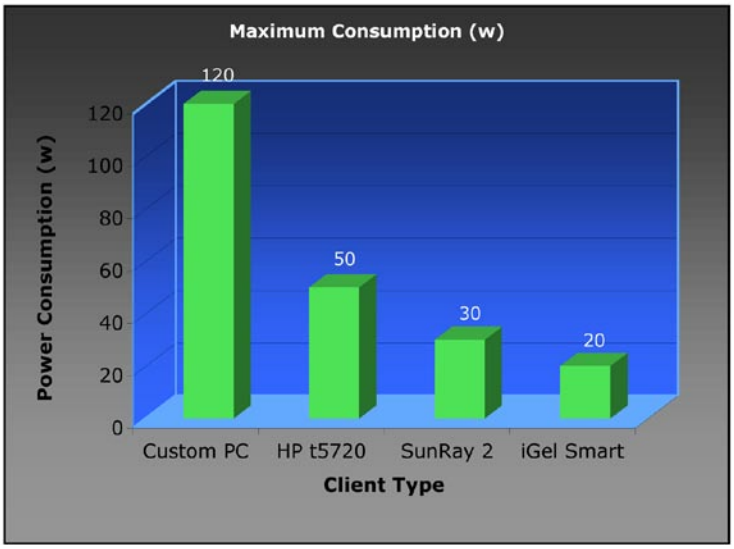
Power Consumption

For the data presented in the graphs on the right, we custom-built a PC using normal components (a 230W Power Supply, with DVD-ROM, 80GB Hard Drive, Celeron 2.4GHz CPU, 256MB RAM and running Windows XP Home). The Maximum and Average Consumption was calculated based on the following factors: copying data from the DVD to the Hard drive (maximum) and working with programs in memory with just a keyboard and mouse connected, along with the screen (average).

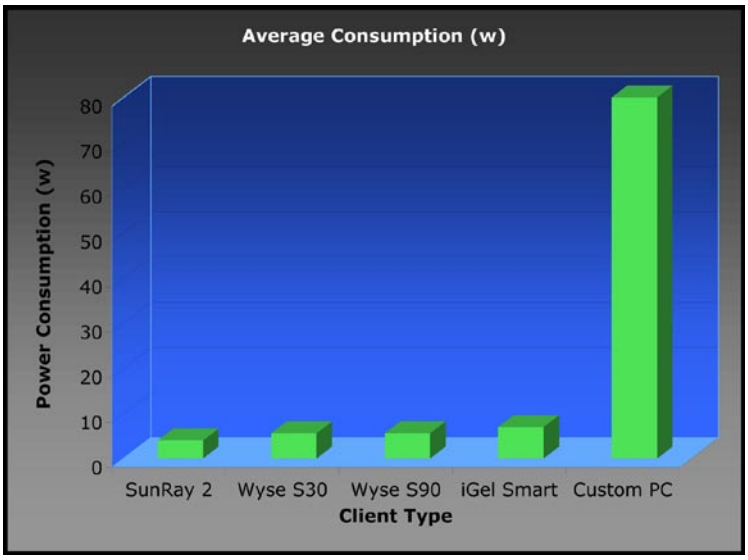
The data for both Average Consumption and Maximum Consumption for the Thin Clients were taken directly from the manufacturers (the documentation included with the machines on the respective web sites). It becomes evident, from the Maximum Consumption graph, that a normal PC is 2.4 - 6 times higher than that of a Thin Client!

Comparing the Average Consumption, the PC consumes 11.4 - 20 times more power than a Thin Client.

Thin Clients are energy efficient not only because they use special components but also because they only offer the bare essentials- that is, no CD/DVD ROM or other forms of removable media devices, no hard drives and no internal expansion cards (some models do offer at least one PCI expansion slot). This also translates to lower noise (almost non-existent in most Thin Clients) as well as significantly lower heat emission. In classrooms or labs with as many as 20-30 computers, heat generated by the machines can pose a serious problem. Needless to say, classrooms in primary schools, especially in Cyprus and Greece, have no provision or any long-term plan of installing air conditioning units, thus making the heat problem a major obstacle in establishing large networks of computers.



A Custom-built PC consumes up to six times more power than a Thin Client (iGel Smart). This is -in part- due to the different type of CPUs used, as well as the -lack of- removable devices such as CD/DVD/HD/Floppy from Thin Clients.



It becomes obvious (based on the chart above) that Thin Clients are extremely energy-efficient as opposed to the average PC available today.

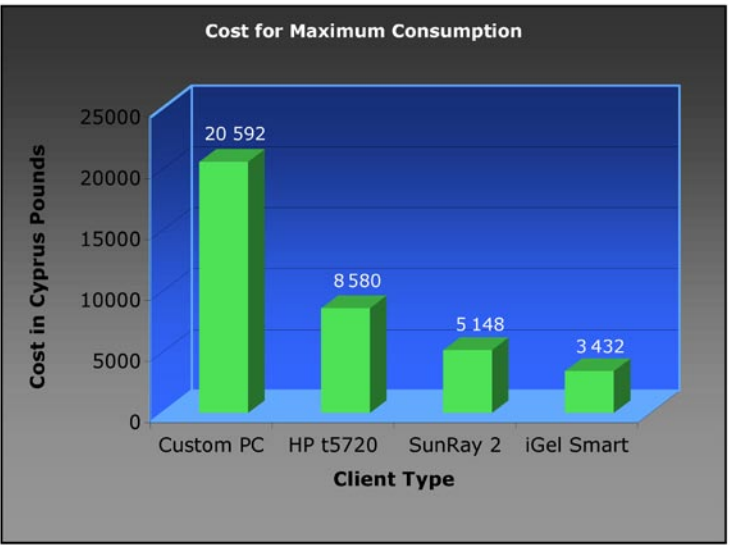
The Power Consumption is based on the documentation/information provided on the web sites of the various vendors. Custom PC is based on an Intel i845 chipset with a Celeron 2.4 GHz CPU, 256 MB RAM, 80GB Hard Drive, DVD-ROM, Floppy Drive, running Windows XP Home Edition.

Wyse offers the average power consumption of its clients.
HP offers the maximum power consumption of its HP t5710 client.

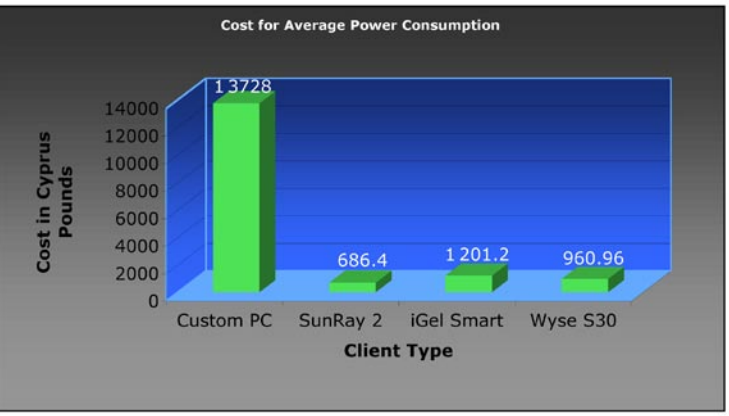
Power Consumption Costs

Power Consumption Costs are a tremendous factor that must be taken into consideration when deciding a mass purchase of equipment. The gains, both in terms of costs and otherwise, can be tremendous.

The Cost for Power Consumption is the product of (Maximum Power x Usage x Cost). The Cost is defined at 0.13 Cyprus Pounds per KW/h. Usage is defined by the product of 5000 Computers (currently in service in Primary Education) x 120 days of use per year x 2 hours of use per day. The estimated costs will vary depending on the cost of electricity, however the price differences between platforms stay unchanged.



Even when most systems are working at their peak, the cost difference between Thin Clients and a Custom built PC is clear- in favor of Thin Clients.



Average Power Consumption is based on information provided by manucafturers, through their respective brochures. All systems are expected to use an external monitor, with one keyboard and one mouse connected (no other peripherals running). The PC is running off its hard drive, with programs already in memory (minimum or no disc activity or CD-ROM/DVD read/write actions).

Power Consumption is often (and rightly so) translated in actual costs spend on electricity. This is, surprisingly, almost never taken into consideration when establishing a significant purchase for large organizations. By calculating the total cost of electricity (yearly costs), we end up with some really interesting results.

Electricity Bills show the way

As mentioned in the previous page, Thin Clients are very energy-efficient and consume much less power than normal PCs.

This power efficiency, at the end of year, can be translated in money costs. At present, the Ministry of Education has at least 5 000 PCs in service (and this number does not include the computers purchased by Parents Associations or donated by third parties to schools. Even if these machines are only used 120 days per year and for 2 hours per day, the yearly cost (Maximum Consumption) comes at 20 592 Cyprus Pounds (0.13 Cyprus Pounds per KWh). Similarly, Thin Clients cost 2.4 - 6 times less in terms of electricity. At Average Power Consumption, a normal PC costs between 11.4- 20 times more on electricity!

These costs are extremely significant and should be seriously taken into consideration. A Thin Client solution is always the sum of all parts, and even when choosing high-end Thin Clients that cost even more than a normal PC, all the added gains are sufficient enough (as we shall examine in the following pages) to suggest a far more economical solution.

It is remarkable, however, that in most purchasing decisions such important factors are not even taken into serious considerations. Also, it is true that PCs today are far more energy efficient than they used to be, but still they are a far cry from what a Thin Client requires to work. And with such models as the new SunRay 2 consuming a mere 4 watts of power, or the 'S' Series of the Wyse Terminals consuming 5.6 watts, or the iGel Smart (7 watts), makes dedicated Thin Clients the most cost effective solution as far as power consumption is concerned.

A Server for all models

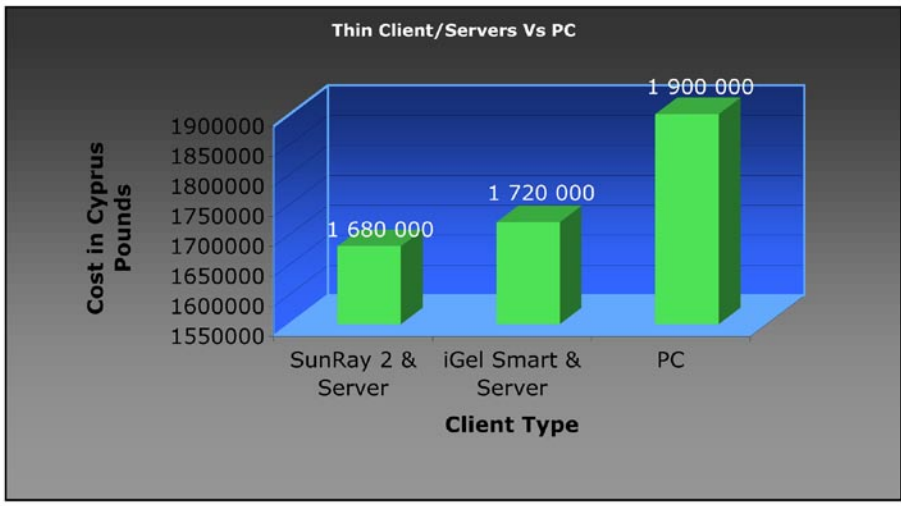
Even when a model of independed 'Fat' Clients is prefered over Thin Clients, a server is still essential in every school or organisation with a large number of computers.

The cost of servers are coming down, as new technologies are introduced and component prices (such as RAM, hard drives and CPUs) come down at a very fast rate. Processors such as AMD's Opteron or the latest Dual Cores by Intel, offer amazing performance for far less than yesteryear's fastest multi-CPU server.

Most schools in Cyprus (Primary Education) have more than 10 computers, and within the next two years they will triple to 30+. However, without a central server to connect all these computers, valuable resources are neither shared nor saved for future reference or use.

One Server Per School

A server in every school makes a lot of sense, even when Thin Clients are not to be used. Servers can be ideal for storing information (such as educational content) that needs to be accessible by all teachers at all times. By using RAID Mirroring, we can ensure that information is not lost if hard drive failure occurs. This will also save student assignments or projects that more often-than not are lost when a hard drive dies. Unfortunately, such a strategy does not exist at this point.



The Ministry of Education is considering an additional purchase of 10 000+ units withtin the next two years (Primary Education). The cost for a total purchase of 10 000 PCs (priced at 190 Cyprus Pounds) is 1.9 million Cyprus Pounds. The cost for the purchase of 10 000 SunRay 2 units (estimated price) along with 500 servers (priced at 1 000 Cyprus Pounds with OS installed) is 0.3 million pounds less expensive!

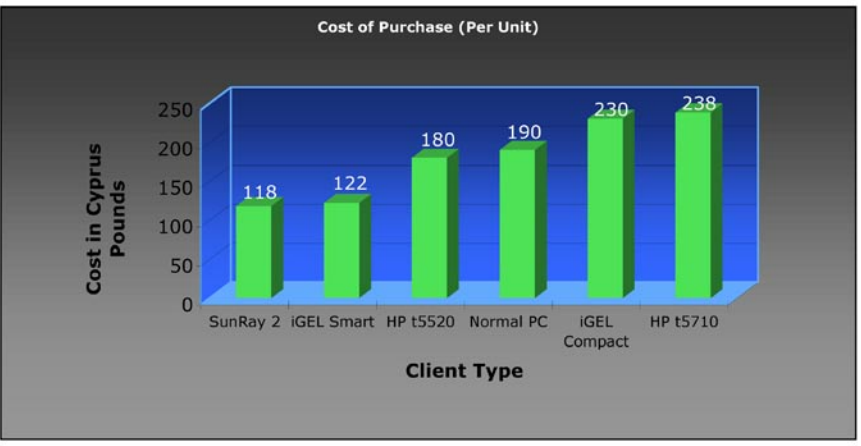
Servers for Thin Clients

Even a Thin Client with embedded OS (ie iGel Compact, HP t5710) offer far too little without a Server (either Linux or Windows Terminal Server). A server, however, poses another cost since all machines have to be purchased with adequate memory and storage. It goes without saying that even a low cost server with the bare minimum can cost up to 2-3 times more than an average fully-configured PC. When assessing the needs of education, a lot of factors must be taken into account and the benefits that arise from the use of Servers cannot be overlooked. The use of non-Windows Operating Systems can drive the costs even further down.

Our experience from the 'Classroom of Tomorrow' initiative, clearly indicate that even a basic server with 2GB RAM can drive 20 clients for normal tasks (ie Word processing, internet browsing, drawing, presentations).

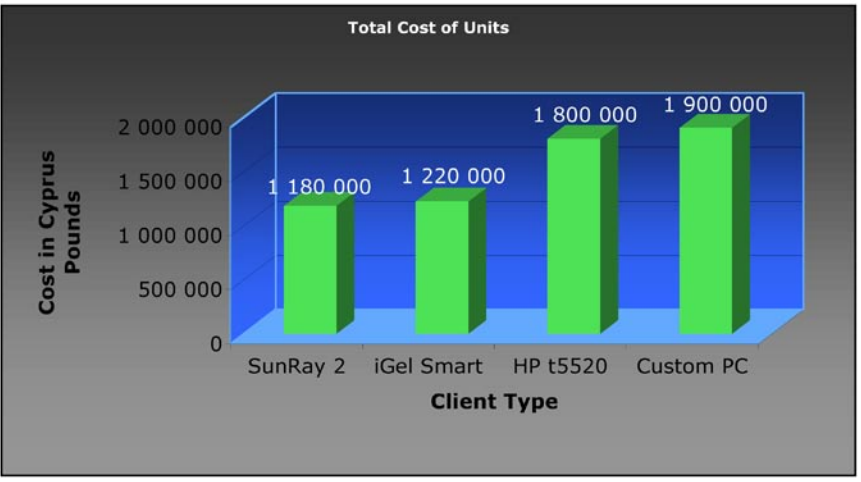
Cost of Purchase

So how much do clients cost? We have examined a combined client/server cost for entry-level clients. We shall examine the costs of clients individually in various configurations and models.



The PC is a custom-built entry level Celeron model with 256MB RAM, 80GB Hard Drive, DVD-ROM, Floppy, integrated graphics, sound, and LAN. It also comes with basic speakers (all Thin Clients include a built-in speaker).

Prices are taken from the official web sites of the various manufacturers with the excpeption of iGel (provided by dealer) and the PC (built by us using standard components). The price of the PC does not include the cost of the Operating System.



The Total Cost of Units is calculated based on the price (as mentioned in the website/brochures of each manufacturer) for a total of 10 000 units. The Ministry of Education (Cyprus) will be equipping all classrooms with 3 computers (up from one) with an additional 10 000+ purchase. Prices will vary when a final price (for all units) is asked, however the difference between models will remain similar.

Thin Clients are not cheap- at least not when we compare what they offer out-of the box with a normal PC. Some premium models (ie HP t5710 or iGel Compact) come with Windows XPe, Flash Memory, PCMCIA slots, PCI expansion slots and much more. For the average network these features can be overkill and they add to the price. For education we recommend entry to mid level models that offer both a price advantage as well as basic yet much needed features.

Price of Clients

Some Thin Client models are more expensive than basic PCs. Features such as extra storage space (in the form of Flash memory), PCI-card expansion slots, Windows XPe tend to drive costs upwards. More basic models with card readers, Linux/Windows CE 5.0 embedded or without any type of embedded software, are less expensive than basic PCs. An entry level SunRay 2 comes at around 118 Cyprus Pounds (estimated), whereas an average PC costs around 190 pages (both machine configurations are exclusive of Keyboard, mouse and monitor). Even the HP t5520 that comes equipped with Windows CE 5.0, an embedded OS, is less expensive than an average PC.

If we take into consideration promotion (educational) offers by various vendors, Thin Client prices will go even further down. The same applies to PCs as well, however Thin Clients are priced more aggressively when large volumes are ordered, especially when intended for educational use.

Cost of Setup

Even though the setup procedure of PCs today is almost automated, it still requires intervention by experts (ie Registration/Activation of products, customisations etc). The same does not apply to Thin Clients, as they tend to allow a far easier setup (in most cases) or no setup at all, apart from the server.

Maintenance Costs

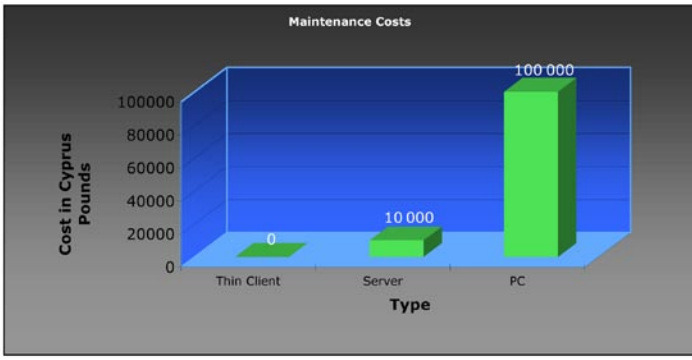
We are not suggesting that the use of IT will sufficiently gap the differences between students of varying level of performance. It will allow us to examine the effect in the way children interact with Maths.

If there is one undeniable advantage of Thin Clients over 'Fat' clients, that is the maintenance cost- in most cases there isn't any. However, that is not to suggest a Server-Thin Client setup does not need maintenance.

Hitting A Brick Wall

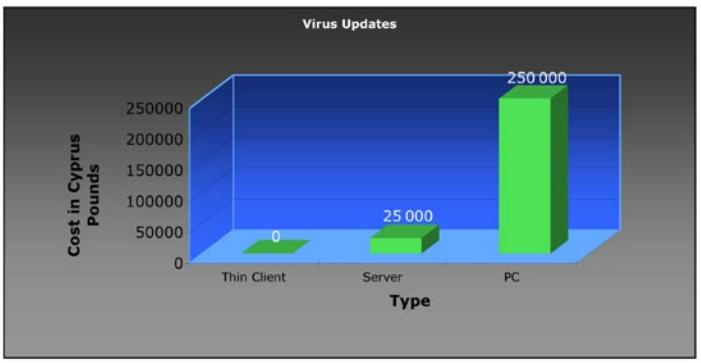
In the next two years, Primary Education in Cyprus will have more than 15 000 'Fat' clients established in schools. This is a considerable number of computers, all running Microsoft Windows, with access to the Internet via ADSL lines. However, no single IT person will exist and private sector will be almost entirely responsible for the maintenance of all these systems. Because each machine will be independent of the other, the only reasonable way of actual maintenance work will have to be made on sight. We need not elaborate on the maintenance hell this will cause.

A Server-Thin Client approach will manage to solve this problem. First of all, the core team of the Ministry will be able to do normal maintenance work through the internet. Since at least one server will exist in every Primary School, the number of computers for maintenance work will be significantly reduced. Thin Clients need little to zero maintenance work done, especially if we resort to purchasing dedicated Thin Clients (the additional 10 000 clients the Ministry is expected to purchase within the next two years).

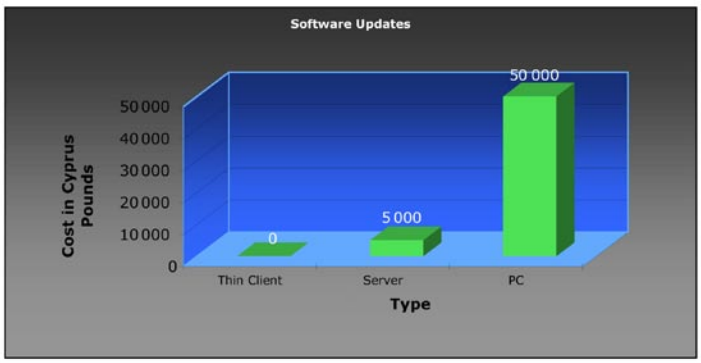


The Maintenance Costs are calculated on a 5-year cycle. The average cost of labor (computer technician) is around 15-24 Cyprus Pounds. An estimated minimum amount of 20 pounds per client and server has been taken into account. The estimate is for 5000 PC clients (the number in use today in Primary Schoolls) vs a number of 500 servers (a number that can cover almost every Primary School in Cyprus). We assume that, during the 5-year cycle, at least once for every machine a technician will have to devote at least one hour for maintenance not covered by guarantee.

The computers already in use, with slight modifications, can be turned into thin clients themselves, with all the benefits mentioned above (more on recycling in the following pages).



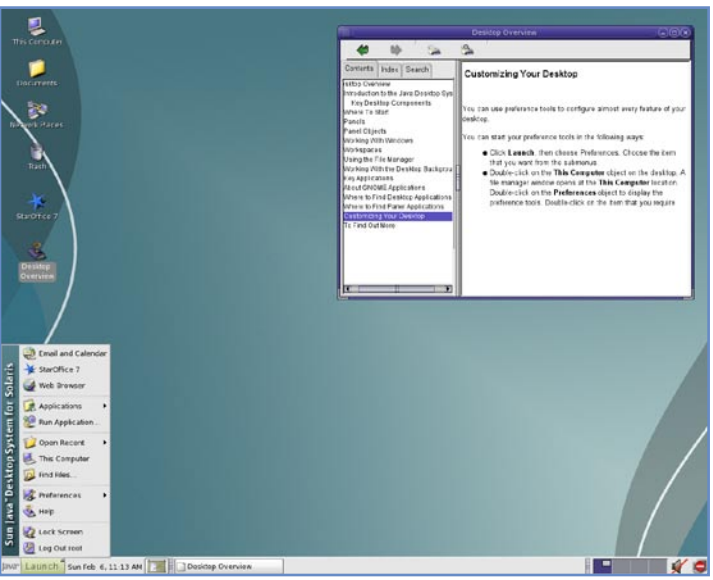
Virus Updates are necessary, especially in an MS-Windows rich environment. Cost has been calculated with a minimum cost of 50 pounds per client (for a total of 5000 clients) vs 50 pounds per server (for a total of 500 servers). The cost covers only the labor, not the actual cost of software. This estimate is for a five-year period.



Software Updates are necessary, since Microsoft releases security updates and patches in regular intervals. Also, most software needs to be updated (ie QuickTime, Acrobat Reader, Media Player etc). The cost has been set at 10 pounds per year per client and server (5000 clients as opposed to 500 servers). The costs are for labor only, and does not include software upgrades (ie MS Windows XP to MS Windows Vista).

Solaris/ Linux & Sun Ray Server Software

Sun Microsystems is arguably one of the leaders in Thin Client technology, offering a complete solution including Server and Client Hardware, as well as software. Sun supports both Solaris and Linux platforms with SRSS 3.+



The Sun Solaris 10 OS offers a customised version of the Gnome Desktop Environment. According to Sun Officials, this is the way to go for the foreseeable future, as Sun will support this environment in future versions of Solaris.

The company behind the term 'The Network is the computer' is one of the leaders in the Thin Client industry. In the last few years Sun has turned its attention to the x86 architecture, supporting not only Intel/AMD processors but various Linux distributions as well.

SunRay Server Software

The technology that allows Sun Thin Clients to work is called SunRay Server Software, or SRSS for short. It is currently in version 4 beta, and our experience (with version 3.1) has shown great potential. Sun was once working with SUSE to release its own Linux distribution, named Sun Java Desktop. However, recently Sun decided to discontinue SJD and instead focus on its Solaris and OpenSolaris instead. However, it continuous to support SRSS on RedHat and SUSE distributions. It is worthy to notice the Nexenta project, an OpenSource initiative that binds together the SunOS with the Debian distribution. It is -at present- in alpha stage, even though reports state that it is quite stable for normal use.

Low Cost, High Support

Even though K12LTSP (covered in the next page) is equally free and Free, Solaris 10 offers a much more robust package as it comes with full support by Sun Microsystems. Also, Solaris comes pre installed with all major Sun Workstations and Servers, thus significantly bringing down the cost of licensing and purchase. To top it all, StarOffice comes preloaded in most -if not all- Solaris installations.

Works with Windows

SunRays can connect to a Windows Terminal Server far more easily with the upcoming version 4 of SRSS. This is a big plus for Sun, since -in many cases- users need to access critical applications only available through the MS-Windows environment. We shall cover this functionality in a later report, once the final version of SRSS is released.

Great, but...

It must be noted, however, that Solaris 10 is far from perfect as a Desktop replacement OS. For starters, it will not recognise (or mount) USB memory sticks automatically. We are sure this will be solved in the next major upgrade, but it is a serious problem to educators. Furthermore, Solaris is not very friendly to non- English speakers, as it offers a very awkward way of changing the keyboard input language. To top it all, software available for Linux will not work under Solaris- instead, educators will have to seriously look for the Solaris versions of the software. If the above are not serious issues for an organization, then, by all means, Solaris is a very robust solution.

LTSP & Linux: Free, free and Powerful

Having the content is one thing. Applying it to the entire classroom and managing the results is a completely different thing altogether. We are building the future classroom on top of an LMS.

If there is one thing I love about Fedora, it is the tight integration between the included applications and the Gnome Desktop. Regardless of what other users say or believe, in my humble opinion Gnome is the Desktop to go with, and Fedora is the ultimate implementation of it.

LTSP has reached version 4.2, bringing on board a lot of significant changes. Less memory is now required per client, USB memory sticks can be mounted on individual clients, and performance has been optimised to support even more clients with no significant performance penalty.

"Say what you want about Fedora- it is my favorite Linux Distribution bar none!"

K12LTSP 5: Beta 3

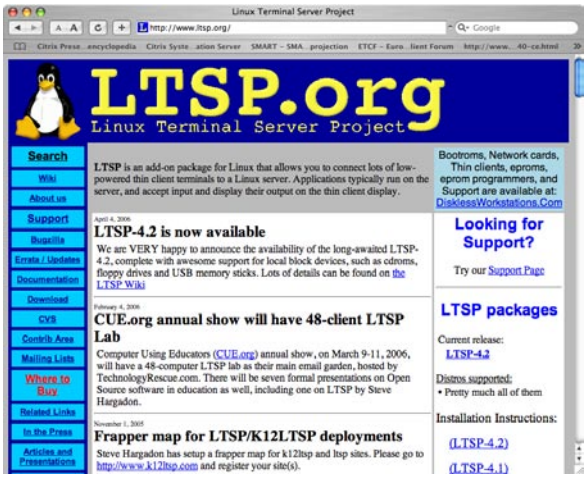
We started our research with various distributions. When we decided to test Thin Clients, we were thrilled to discover K12LTSP (then using Fedora Core 3 beta). Fedora Core 4 kept us through the year, and we will keep it until Summer of 2006. Come September 2006, however, 3 of the 4 schools in our research will be Fedora Core 5/LTSP (K12LTSP 5) based.

An Almost Magical Mix

The first thing that strikes you with Fedora/LTSP is that it simply works. Starting from the installation - a straightforward approach- to the first time you boot the first PC turned Thin Client. It all works perfectly with zero to little extra configuration (as long as you have at least two LAN cards in the machine). Even a humble Celeron 2.4GHz machine with 1GB of RAM and 80GB hard drive, can happily manage 13+ recycled PCs used as Thin Clients. This is remarkable, for such a distribution that is entirely managed by the Community.

The K12LTSP distribution (http://www.k12ltsp.org) comes preloaded with most software an educator might need. These include OpenOffice (the latest version), Kig (geometry), Celestia (Interactive Solar System) and many more.

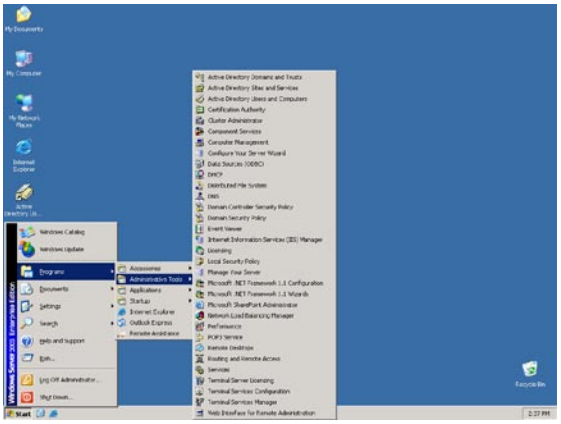
Clients need not have the exact same hardware. By assigning MAC addresses in the appropriate configuration file, we can define how each client runs and with what drivers or settings. For more information on K12LTSP you can check our previous reports (http://www.apoplous.org).

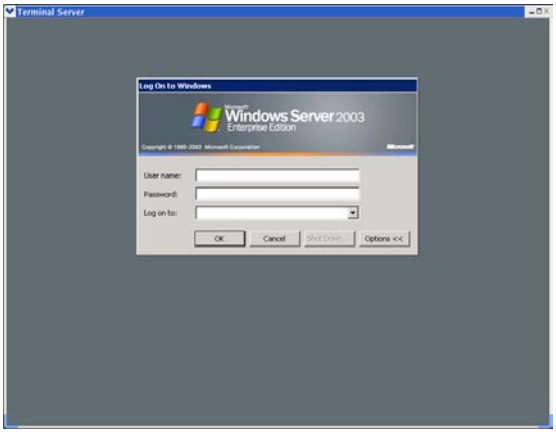


Microsoft Windows Terminal Services

Microsoft is the marketshare leader in the desktop OS market. Its experience through the years , along with its huge market share, has given her an advantage over other systems.

A familiar environment, as well as the huge library of available software and technologies are probalby the most significant reasons why people still prefer the Windows platform over other competitive systems. Ironically, it is not users themselves but rather IT personnel that prefer Windows over other operating systems, and that is because they tend to have extensive knowledge of the system and prefer a homogenous network with the server and desktop clients running an OS from the same vendor.

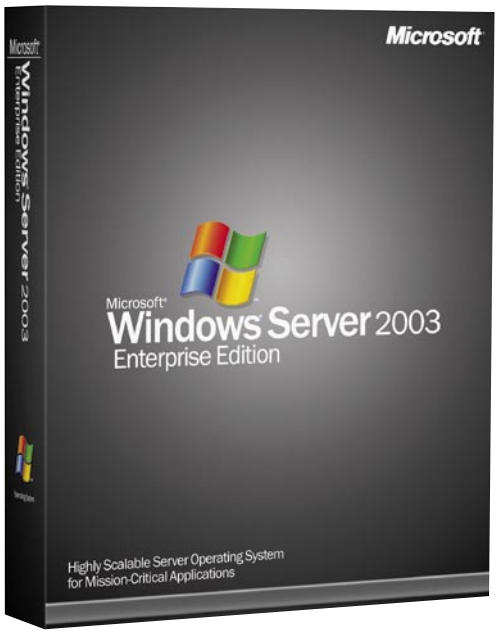




Microsoft Windows 2003 is accepted by the market as a viable Unix alternative. The Terminal Services supported by the latest version are much better than previous implementations and it offers a very serious alternative (with obvious advantages and drawbacks) over the Solaris & Linux/LTSP solutions.

Windows Terminal Services

Actually Microsoft did not invent the foundation of its Terminal Services. What it did -initially- was to acquire technology by one of its main competitors- Citrix. The latest versions, however, offer several significant advantages for users flirting with Thin Clients.



'Industry-standard' OS

Probably the most important factor for choosing Windows Server 2003 over alternative operating systems, is the level of acceptance by the market. Almost everyone owns a Windows-based PC (if the 95+ percentage of Desktop penetration is any indication) at home, making the environment a familiar one even to novices. Granted, Linux and Solaris have progressed enough to be considered quite user-friendly, but most people tend to consider MS Windows a much friendlier system to work with.

This is not unsubstantiated, as most tasks are more easily done under Windows than under other operating systems (with the exception of MacOS X). MS Windows, by default, supports such technologies as QuickTime, Shockwave etc that are not compatible with Solaris/Linux and they probable never will! Add to that the breadth of software titles available to the Windows world, and the MS-Windows Server looks the more impressive.

On the other hand, Windows tend to require more maintenance work than other operating systems. Constant download and installation of security updates are required. This is mostly due to the fact that MS Windows are by far the most popular OS in the market, and viruses and other vulnerabilities have started surfacing for both Linux and MacOS X as they become more popular.

Citrix Presentation Server

Is the time right to move back to a thin client model for our schools? They do look promising, but are there any heavy compromises?

Citrix Presentation Server

Citrix is a well established and highly respected technology for Terminal Services.

All processing is done exclusively on the server, and only instances of screen activity are transmitted to the client (be it window dragging or mouse movement). Even though Citrix technology is regarded as one of the best in its field, the costs which still require Windows licences, make it much less lucrative for the educational market (where every pound counts). Most clients today support Citrix services, offering a very stable solution, even through the web.

Citrix for future use

Technology from Citrix will prove essential in a future research, with clients and servers being part of a Wide Area Network. In that case, through the internet we will test the performance of clients and how they work with a centralised server. Because of the compression offered by Citrix servers, we expect to have a significant performance gain over standard Windows Terminal Services. This will allow, in practice, to do away with the servers in schools altogether or to offer a wide-area network alternative when the actual school server goes down.

We don't expect to even initiate such a research until at least 2-4 Mbps lines are established in our schools, something that might happen in the next 2-3 or more years.

Cost of Recycling

Sooner or later, all of the 5 000 PCs already in service in Primary Education will have to be removed. Our research has proved that we can succesfully recycle and reuse them with slight modifications.

The 6th Lakatamia Primary School is a model of computer recycling. The actual cost of the entire lab (13 clients and one server) is under € 1 000!

Old computer cases can be replaced with newer models that take less space, generate less noise and consume less power.

At least one computer (Intel-based running Windows) exists in every single classroom in our Primary Education. Most of these systems are already struggling to keep pace with new software, as they are based on Pentium I or Pentium II technology. Eventually, even the systems we have just received, will become obsolete.

Reusable through Recycling

Dasoupolis Primary School (2004-2005) and now the 6th Lakatamia Primary School, are just two examples of establishing ultra-low cost computer labs through the recycling of obsolete machines. In previous OpenEducation Reports we went through the systems and the procedures used. The same or similar method could be applied to the aging machines we have in service today. At least a basic LAN card with the appropriate BootROM is required, so that the PC can run directly through the server, thus turning it into a Thin Client. Devices such as CD-ROM, floppy and hard drive can be removed as they are not needed in a Thin Client-Server environment.

Making the right choices

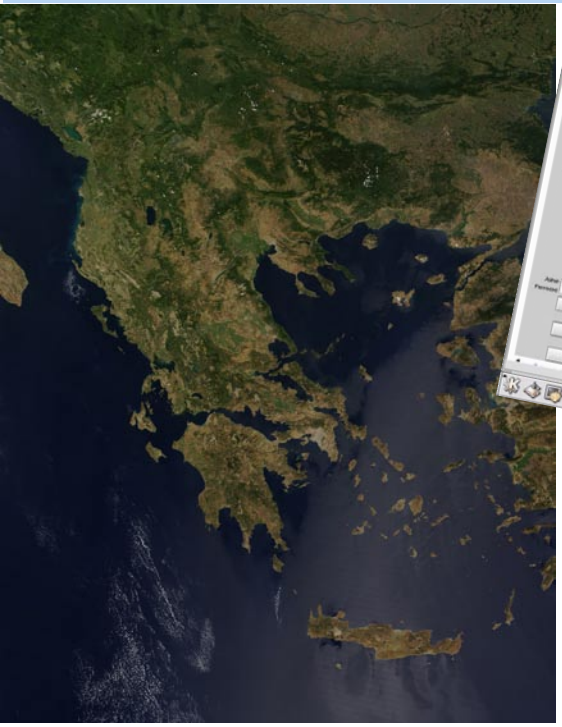
If the Ministry adopts the Thin Client/ Recycling approach, then we can look at even more optimizations. As shown in previous pages, we can save on electricity bills by removing unnecessary devices (removable storage devices), or even change the cases altogether with smaller ones that have more power efficient power supply units.

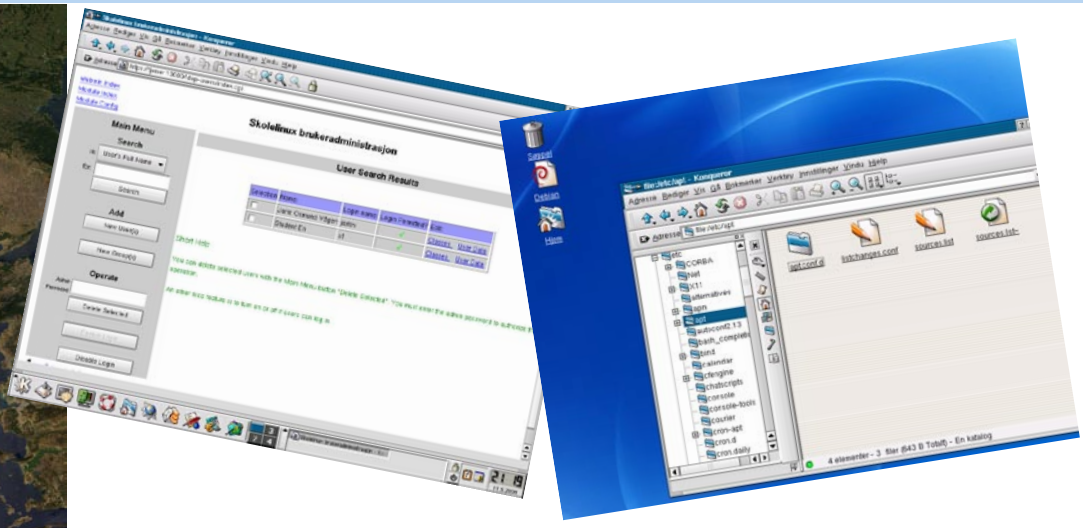
Instead of purchasing LAN cards to install in the recycled units, the Ministry can change the requirements for new purchases to include this capability on board, a feature supported by almost every Intel motherboard sold today.

Our final goal is not to keep the number of clients set at 3 for every classroom, but to slowly increase that to a more effective analogy of clients per students. Also, savings in costs will allow the purchase of additional equipment such as interactive whiteboards, or the development of digital content.

Thin Clients for Greece's Education

As mentioned earlier, the installation of a fully-working Linux Terminal Server is quite straightforward, and exceptionally easy.





Quite ironically, the greatest interest for our research on Thin Clients has been shown by the Greek Ministry of Education. Thanks to a presentation done by Mr. Lefteris Papakostas and mr.Christopher Saul of Sun Microsystems Europe, the Ministry of Education and Religion has contacted us to exchange our experiences and knowledge on Thin Clients and computer recycling.

Greek Pilot Study

Greece has shown great interest in what we have been doing for the past two years. In their own words 'we seem to be ahead of them' in using OpenSource Software and Thin Clients. Their intention is to start a pilot study of around 20 schools (Secondary Education) with recycled computers used as Thin Clients.

Prior to our contact, the Ministry itself was engaged in active research on using Linux and other OpenSource Software for educational use. Their experience was more focused on the Skolelinux distribution, but our recommendation was also for examining both the CENTOS/LTSP distribution as well as the K12LTSP we are using.

As alternatives to MS-Office we have suggested both StarOffice 8 (which is free for education) or OpenOffice 2.02. The Greek OpenSource Community is well established and we already have a (testing) version of a fully-translated OpenOffice 2 suite. The team behind the OpenOffice localization are hard at work on the thesaurus.

Several alternatives for applications only available to the Windows platform have been suggested. For example, one of the platforms used for introduction to programming is Microsoft Visual Basic, only available on the Windows platform. However, REALBasic is available for all platforms (Linux, Windows, MacOS X) with the Standard edition available as a free download (Linux version only).

We are planning an official trip to Athens sometimes late May to early June, to present our findings in more detail and offer our resources to our colleagues.

The Final Verdict...

With all the advantages mentioned in the previous pages, it would seem that Thin Clients are the ultimate solution for education. Are they?

Thin Clients come in all colors and shapes, and all have a particularly small form factor. When deciding upon a purchase, a lot of issues must be taken into consideration. Two of the most notable features are probably the embedded (or not) operating system, and the integrated (or not) screen. Both approaches have pros and cons, and should be considered with extreme care.

It is not uncommon to regard education as one of the least priorities of any government, in any country. After all, most people tend to consider (and at some point they might be quite right) that spending in health care, defense, communications etc is more important than spending in education. But, education, is like money in the bank. The more you save, the more you get back.

Technology for change

Technology plays a major role in whole class learning. In order to have the most impact, it has to be implemented properly. And proper implementation means the right ratio between students and computers, with the ideal being a one-one scenario. Also, content and methodologies are extremely essential but they tend to be quite costly to produce.

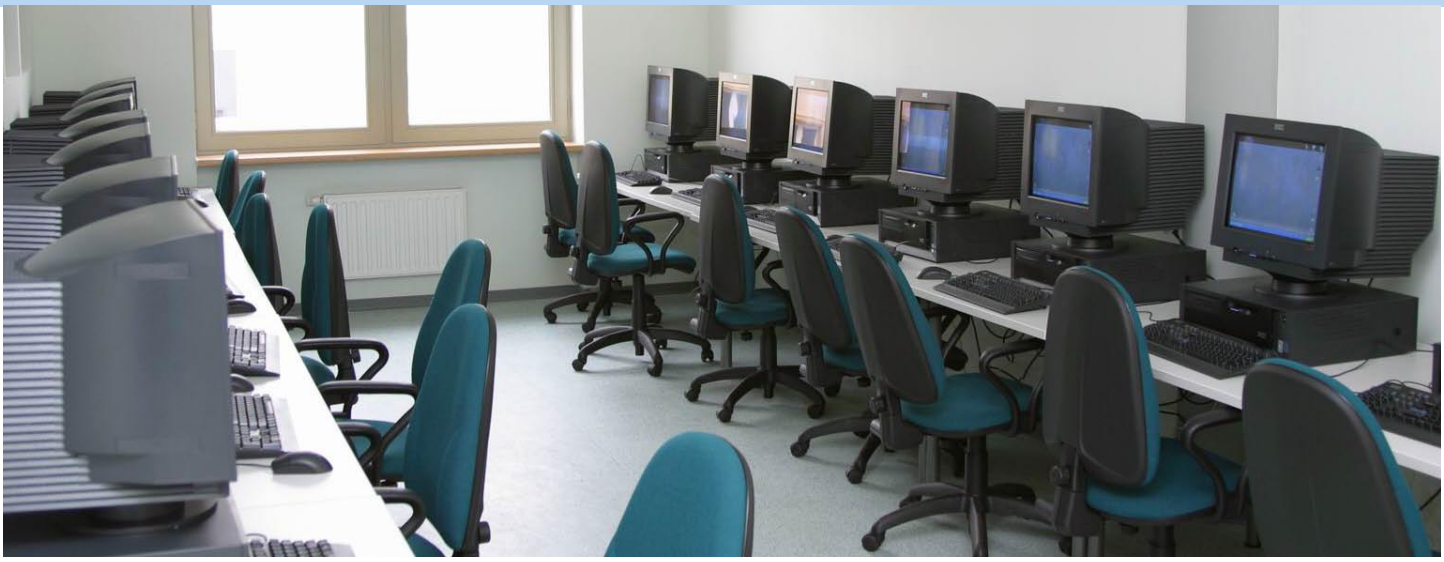
Thin Clients can be a viable and realistic solution for bringing more clients inside the classroom while at the same time reducing the money spend in actual purchases or unnecessary maintenance. By recycling computers, we can extend their useful life and bring more value to our initial investment. By using dedicated Thin Clients we can even increase our savings across a number of very important areas (ie power consumption).

But Thin Clients, as much as we like them, tend to have some serious shortcomings as well. With the exception of some models that feature built-in graphics hardware (ie iGel Compact line, HP etc), most Thin Clients are not suitable for video playback, an essential feature for education. New compression algorithms as well as faster networks can do away with most of these problems.

In order to move ahead, we have to take all factors into consideration. Thin Clients are by far the perfect solution for all problems, but, as with Democracy, they might not be perfect but they are the best solution that exists at this point in time.

When NOT to use Thin Clients

Thin Clients are a good solution for most labs. There are cases that require a computer with fast CPU, lots of RAM and fast graphics cards.



Not all situations benefit from Thin Clients. In a Multimedia Authoring Lab, probably the best solution is to go with 'standard' PCs with fast CPUs, lots of RAM and hard drive space and of course fast graphics cards.

Benefits aside, not all needs can be effectively covered by Thin Clients. In some cases a 'fat' computer is more suitable, especially when specialised operations will take place.

The 'Fat' Client

Across the planet, there are thousands of small companies that operate with just 2-3 people. These companies usually have one or two computers. In cases such as this, using a 'Fat' client is more appropriate than a Thin Client/Server setup.

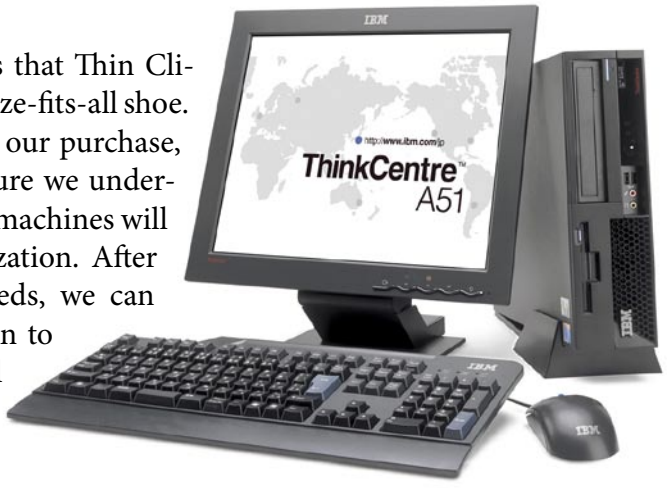
Also, for children working with their computer at home, a normal computer is much better suited since they usually require lots of storage space and fast graphics cards to enjoy the latest 3D games.

The same can be said for the hobbyist who wants to create DVDs or music CDs. Even the fastest computers tend to start crawling when we encode DVD-quality movies.

Professionals who make a living with their computers are also a category of people who benefit more from 'fat' computers. Especially graphic designers or architects need extremely fast machines that feature 2 or even more CPUs and huge hard drives.

Universities that teach graphic design or multimedia authoring, 3D graphics or video editing surely require the fastest possible machines in the market.

It becomes obvious that Thin Clients are not a one-size-fits-all shoe. Before deciding on our purchase, we have to make sure we understand the roles our machines will play in our organization. After we outline our needs, we can be in better position to select the right tool for the job.



One Client To Rule Them All

Can a single machine be created that will replace all other clients? What should a machine have to be called the Ultimate Client?

Thin Clients have a very small form-factor. Specific models come integrated with a TFT screen. Other can be mounted on the side (or the top) of a screen. Usually they are so small you can even place them behind or on the side of the monitor.

The Thin Client market has some impressive models. Some are just appliances that do nothing without a server. Others are full-blown computers inside a tiny case, and have such features as flash memory, PCMCIA slots, PCI expansion slots, fast CPUs and acceptably fast 3D graphics chip sets. Some also have an entire operating system, be it Linux or Windows XPe. What would constitute the perfect client?

Jack of All Trades

What we would like to see in the ultimate client: first of all, we would love to see a machine that boots directly from the server. But, if for any reason the server is not available, it should revert to a built-in operating system (Linux, Solaris, MacOS X or Windows).

Even when working through the server, all graphics processing (ie dragging of a window, playback of animations or digital video) should be handled by the local GPU (some clients feature ATI graphics chip sets onboard). The system should also allow a given (upgradable) amount of space in flash memory for storing applications and data.

A good selection of software would be an internet browser, an email client (Firefox and Thunderbird come to mind) with at least a basic Office suite (a cut-down version of OpenOffice with just Writer, Impress and Calc) and of course a Media Player for Audio and Video playback.

Some clients already offer most of these features, in one way or another. What we have noticed,

in our amazement, is that they still have a long way to go before they become fully functional. For example, an iGel Premium works quite well on its own (with the embedded Windows XP environment) but works noticeably slower when connected to a Windows Terminal Server.

A SunRay 1 and 170, on the other hand, don't offer any GPU or embedded OS but they tend to work remarkably fast through a Linux/Solaris server. Try basic 2D animations on these clients, and you will get disappointed. Plus, they don't work if something happens to the server.

A perfect solution does not exist. Thin Clients are a technology that has just started to make an impact. We are quite certain that within the next five years a lot of amazing things will happen and Thin Clients will be propelled to high grounds and start seriously affecting the market share of standard PCs. As flash memory prices go down on an almost weekly basis, Thin Clients will get more and more features. And with the developments of such GPUs from nVidia and ATI that can work within the confines of mobile phones, we are quite certain that we will see quite soon Thin Clients that can outrun most PCs with fast graphics cards.

Thin Client Vs Laptop

What is the point of discussing about Thin Clients when inexpensive laptops are (supposedly) around the corner? Should we hold our breath for these wondrous machines, or buy into Thin Clients today?

M.I.T.'s Paper and Negroponte managed to cause quite a stir when they announced the imminent release of the '$100 laptop' or One Laptop Per Child initiative. Can this be the perfect solution for education, or should we invest in today's thin client technology?

The Laptop is the client

Thin Clients, even those with embedded operating systems and basic storage space in the form of flash memory, are highly dependent on the server. This is because they need to use more and more processing power as new software is developed and new standards are set. Also, the substantially small amount of available storage space in Thin Clients prohibit the installation of lots of (necessary) applications such as an office suite (ie OpenOffice), Instant Messaging, Graphics manipulation program (ie Gimp) or other titles. The OLPC initiative is quite bold and probably resembles the best possible solution for students. After all, they will have a wireless client on their desks that they can carry home at the end of the day and bring back to class the following day.

Still, a server - based approach will be necessary, since the server will offer the extra processing power we will need to be quite future- proof (or at least as future proof as possible). Applications not included on the laptop can run through the server, in a similar approach we described in the previous page. That way, even though the proposed laptop design does not include lots of memory or storage space, we will still be able to perform more tasks through the network.

Prospects for education

Even an ideal setup of thin clients can become quite inflexible and 'messy'- just count the number of cables required (power cable, LAN cable, Mouse/Keyboard cables etc). A classroom where all students carry their own laptops that can access the network wirelessly is the ultimate solution. No wires means students can place the laptop anywhere they want, and at the same time make the classroom arrangement according to your needs.

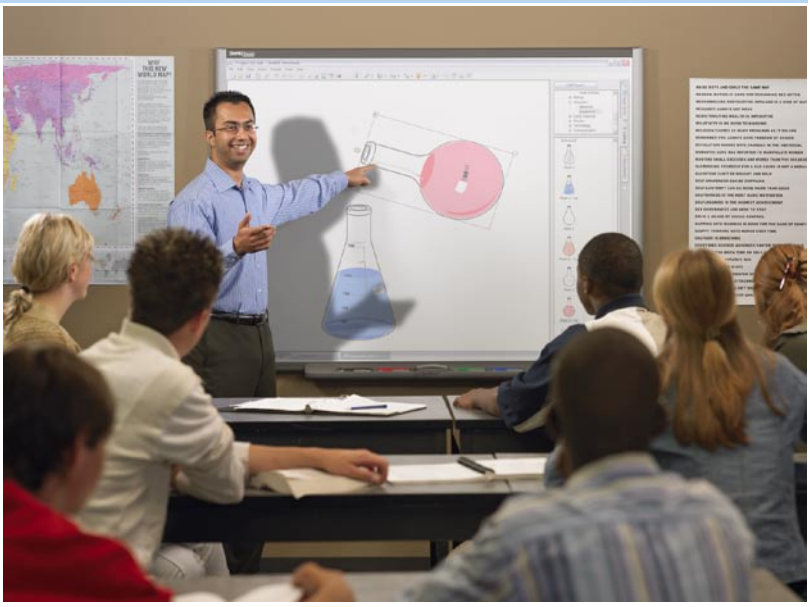
Right now, what we experience is that the computers have to be placed in specific order and in places where the wiring will not be directly accessible by the children (for both safety and cosmetic reasons). This is a major headache in every classroom that aspires to be transformed into a multimedia lab.

Of course, we are still months away (if we are still on track) from the official release of The Laptop (www.laptop.org), and we will continue reporting on it as more information and the first reviews begin to appear.

Until we are certain of it, the Thin Client is still the ultimate computer for the classroom.

Interactive Whiteboards in the Classroom

You might consider it a luxury, but even in a classroom that is not computer-rich, the impact of an interactive board is tremendouss



The wall-mounted model poses a serious drawback: our shadow falls on the board, covering most data. That way, it is recommended (if possible) to place the projecton on the ceiling. The results will be much better, especially when children use the board.

All images used in these pages (with the exception of images from the actual classroom in Cyprus) are property of SMARTtech (www.smarttech.com).

When we decided to create the perfect -in all aspects- classroom, we found that one factor was still missing- an interactive whiteboard. Fortunately, Achelec (Cyprus SMARTboard dealers), as well as SMARTtech itself, believed in our vision and decided to donate us one of their larger wall-mounted whiteboards.

First Impressions

Our school principal is not impressed easily. After all, we do have a setup with one client per child in the school, all using high-quality TFT screens (most schools have only one client per classroom with a bulky CRT screen). However, the first time he came across the SMARTboard, he declared that 'we have moved from writing on stone plates to writing on paper'. Indeed, humankind started recording events when they realized how to handle a more flexible material- papyrus and then paper.

It is hard to describe how it feels like to have an interactive whiteboard in the classroom. The impact not only on the children but on other teachers as well is tremendous.

The most valuable tool

Ask any teacher what he/she considers the tool of choice in the classroom. The answer is one and quite simple: the white/green/blackboard! It is virtually impossible, for most subjects, not to work or show information on the board. But the prospects of having an interactive board are simply tremendous.

Geography? No problem! Just click on the map of Europe and then let's click on the country we need to examine (let's say France). You want to examine why France is self-sufficient in agricultural products? Just click on the board and suddenly what you get is a geomorphology map of France. After a few days with it, you begin to ask yourself how you could work without one!

Living with the board

Regardless of what teachers think, the most obvious crowd for an interactive whiteboard are students.

We are quite proud of our classroom, since it offers us a technology-rich environment to work with. However, adding an interactive whiteboard really helps to boost learning in new ways.

One thing we know about children is that they are hard to please or impress. This is expected since children nowadays are much more technology-savvy than our generation used to be. Most of them (around 85% of our students) have a mobile phone, and almost everyone has at least one game console (PS2, Xbox or GameCube). The vast majority of children also have access to a computer at home.

Student Reaction

For reasons mentioned above, our students are not easy to impress. However, once they get used to using the interactive board, it is hard to switch it off or use the standard marker-only board. Pretty soon the entire school was aware of the new board, and everyone -during breaks- was visiting the classroom to play with it. So, what we did was, to allow children to have a go at the board and test the responsiveness of the interactive markers (they only 'write' when the board is online).

What impressed the most is the ability to move images and clipart from the included gallery to the center of the screen and then enlarge it, rotate it or even combine with other elements. This creates a far more sophisticated level of approach to the actual information. Gone are the days when we had to make rough sketches on the whiteboard so that we could explain basic concepts of mathematics to the children. Or struggling to find the perfect map in History or Geography (and in most cases we hardly have the proper maps for all subjects).

First conclusions

It goes without saying that this is a tremendous tool. Most teachers are quite skeptical on the actual impact the computer can have on education and learning. Most are even quite negative on the actual benefits gained from using a computer. However, an interactive whiteboard blends perfectly with the 'traditional' way of showing information, yet in an evolutionary way!

We would like to thank both Achelec (Cyprus Authorised Dealers) and SMARTtech for kindly donating us the SMARTboard.

Choosing the right model

Depending on the budget and the uses, various differnet models of interactive whiteboards can be used. We try to examine some of the models and their appropriate uses.

Usually, many companies follow the 'one size fits all' strategy with their products. This was actually revolutionized for the first time by Henry Ford ("You can have a Ford T any color you want as long as it is black!"). Fortunately, this is not the case with interactive whiteboards. Models used here are based on the various SMARTboards.

Wall mounted Board

Probably the most common type of interactive whiteboard. It comes in various sizes and it works in conjunction with a computer and a projector. The board is powered with a single USB cable (!). The computer is connected to the projector so that whatever we load in memory gets shown on the surface of the actually board.

This approach has two serious drawbacks: first, in primary school classrooms we tend to need as much light as possible, something that causes problems in viewing images on the board. Second, and maybe even more important, is the fact that our shadow falls on the board, covering important information while we work with it. One solution is to place the projector on the ceiling, but this is not a perfect solution.

LCD & Plasma displays

One specific model of interactive whiteboards can be mounted on the front of a plasma or LCD screen. This is a very good solution since these type of screens don't take too much space on the wall, requires the minimum depth, can be used (most models) with adequate light in the classroom and can be used effectively without any shadows caused by us. However, models more than 42 inch are way to expensive and as far as we know there is no model for sized more than 50 inches.

Rear-projection

Rear projection boards offer an intermediate solution, since the projector is on the back of the board. In this case, we do away with the shadow problem. However, it does require a considerable space from the back of the wall. Some models can be integrated within the wall but this is not always possible (still it would have to be placed within the wall in a special cavity).

It is quite fortunate that such solutions do exist. What we believe is that, with the prices of LCD and plasma screens going down, very soon we will be able to use 50 or even 60 inch models for the same price of a projector/wall mounted board we can purchase today.

Sharing the board

An ideal situation would be to have one interactive whiteboard in every classroom. This is wishful thinking, at least for now. What we can afford, however, is to have a portable board that can be shared.

The impact of an interactive whiteboard on student engagement is quite considerable. Therefore, some kind of solution must be found in order to integrate this specific technology in the classroom.

In education we have to be realistic. We do believe that at some point all classrooms will be equipped with at least one interactive board. In the short term, we could equip our schools with portable interactive boards to move from one classroom to the other.

Schools & Projectors

Every school in Cyprus has been provided with at least one projector. These are usually moved from one classroom to the other and shared with all teachers. It is a model that works, as long as teachers have an understanding on when to use it and when to share it with others. A similar model could work with a portable interactive board.

Wheel it around

One of the most obvious obstacles would be to move the board from one classroom to the other. Fortunately solutions do exist for placing the board on a wheeled metallic structure that allows the easy movement from one classroom to the other. The problem persists when we have to move the board to a classroom on a different floor. In such occasions, at least two boards could be used, one on every floor.

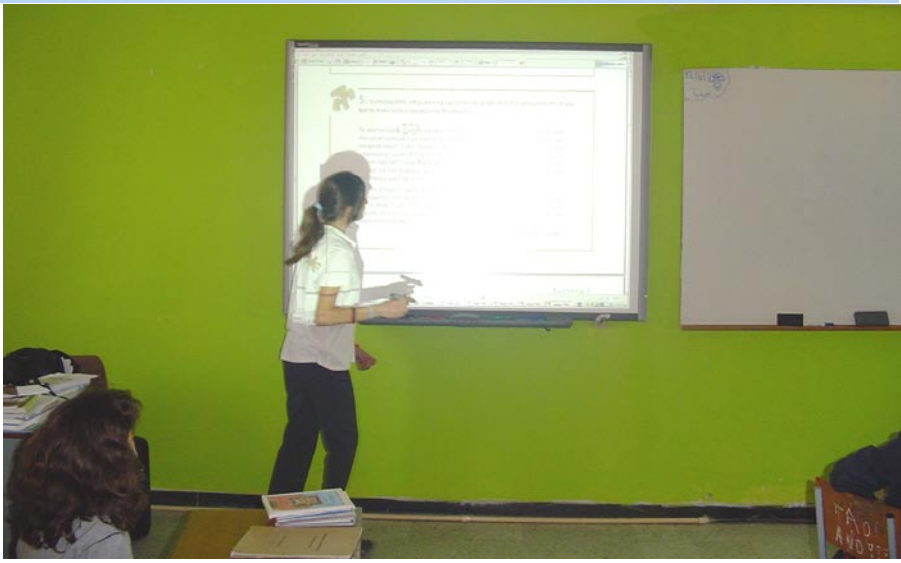
As a solution (having to move the board and the projector from room to room) might not be ideal or elegant, however it is a viable solution that can work- at least in the short term.

We could even start with a small number of boards in every school, a solution that is both cost- effective and allows the better sharing between classes. After all, many subjects do not require a board, at least not all the time (if at all).

Obviously, at some point the perfect solution is one for every classroom. However, with IT spending in education decreasing year over year (worldwide), we have to make do with what resources are available.

Meet the accessories

An interactive board is not just that- a board. It is actually the sum of all its parts, including software, resources and accessories.



We were quite fortunate to have the new books (we are getting them for next school year) in pdf format. Our students worked on exercises from the new books using our SMARTboard. Everyone, for the first time, wanted to visit the board for a try on the exercises!

The first time I used a Wacom art pad, i was amazed by the responsiveness and the quality of not just the pad itself but the included pen and software as well. The same is true for the SMARTboard.

The Markers and Eraser

Quite remarkably, the board comes equipped with 4 'markers' that come in 4 colors: black, red, green and black. These are no 'real' markers since they only work in conjunction with the actual board (and then only when it is powered). The board recognizes that the appropriate color marker has been lifted thanks to a sensor on the base of the unit. It is quite intriguing to notice that, even when we are holding more than one colored marker in hand, the board can still recognise the right color. However, more than one children a marker to hold, and the board becomes confused! This is not a serious issue, but quite interesting to look at (especially if you like abstract painting!).

The eraser is just that- it erases anything we created using our markers. A circle appears on the board to show us the erasing surface and everything within the circle becomes -you guessed it!- erased. Our only minor complain is the responsiveness of the board- it is not a snappy as we would like to, even when having the board connected to a USB 2.0 port from which it gets electricity as well. This is not a factor that diminishes the effect the board can have in the classroom, but it is a nuisance nevertheless.

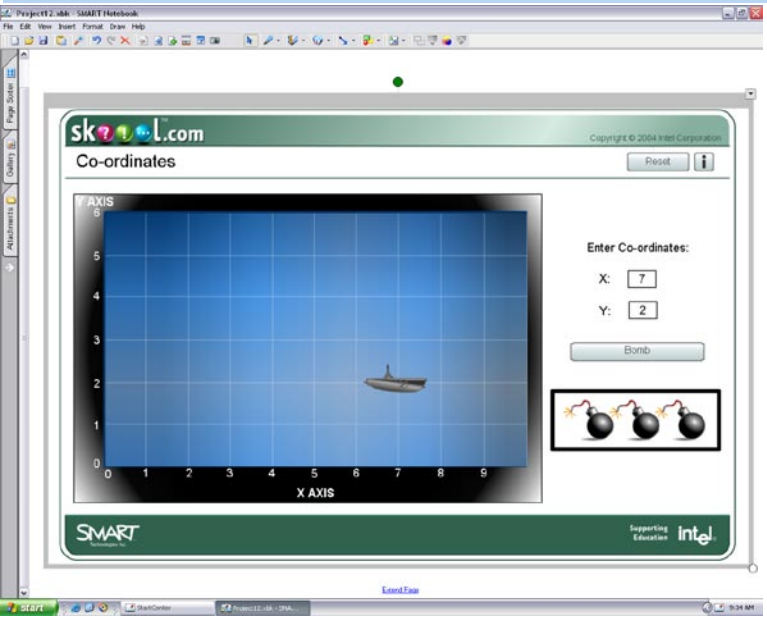
The finger is the mouse!

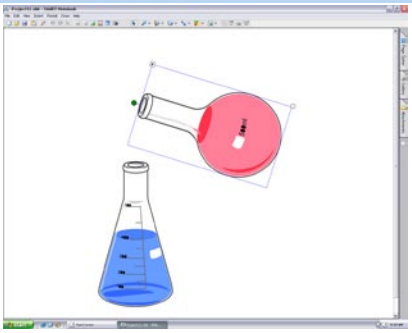
Actually, our finger can be the ultimate pointing device! In most cases we will be using our finger to drag and drop items either from the included libraries on the screen, or just to move windows around. It can become quite fun after some time, and it is something that really engages children. We have noticed that even shy children that tend to avoid standing in front of the classroom, now seem to forget about it and just 'play along' with the board. This is tremendously important, as we have seen our entire classroom being engaged in what we have been doing with it for the past few days.

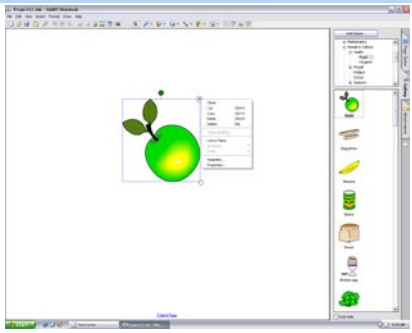
Of course, as A. C. Clark put it, "any sufficiently advanced technology is indistinguishable from magic". And magic is what we need to transform learning!

Resources at our disposal

Regardless of the technology we use, without the proper resources the effect of an interactive whiteboard -or any technology- can be diminished quite easily after the 'magic' effect is gone







The content provided with the SMART Notebook is reall impressive. And the fact that vector graphics have been used, allows us to rotate and resize the objects at will without losing any quality.

What do we need to get technology working in the classroom? With one word: content! And this is a major problem, not only in Cyprus but (from what we understand) in the entire world.

SMART Notebook & Content

An interactive white board can be used with almost every application available on the computer. Fortunately, we are happy to report that SMARTboards work perfectly with both StarOffice as well as OpenOffice (with full functionality) under Windows. We are in the process of working entirely under Linux, since SMARTtech has included 'apoplous' in the beta testers of the Linux version of SMARTideas (more on this next issue).

One of the most useful tools for the board is Notebook. As the name suggests, it can be used to take 'notes'. In notebook mode, we can use the board as we would with any ordinary board- write with the markers, make drawings etc. However, click on a specific spot on the board and you end up looking at a very rich library that includes hundreds of images sorted in categories. These are in vector format and as such can be placed on the board and then rotated and re sized without any loss of quality! Some of these images are used as backgrounds while others are individual objects. What is more important is that we can use our own clipart or images, or even download from SMARTtech's web site for free. This is a tremendous advantage, since it gives us valuable content for no charge at all (other than the initial cost of the actual board).

Furthermore, once we 'fill' the screen with images and text, we can just insert another 'page' (and the previous one can be saved for later use). This is extremely important since it allows us to save our work and come back to it later. Many times we have to recreate drawings or rewrite exercises in order to explain something in more detail to the children. This way, we can retrace our steps and go over information again and again.

Animations & Simulations

Animations are extremely important for education. For example, we can show how frog's eyes are independent from one another, by using a simple animation. Or, we can even show how the Sun, Moon and Earth move in order for a solar eclipse to be observed.

Simulations are also very important, since we can recreate in the classroom, experiments that are either impossible or far too dangerous to try ourselves. For example, we can observe the effects of a huge asteroid approaching the Earth, or the impact between a car and a brick wall at a given speed. Both animations and simulations can be downloaded from the SMARTtech site.

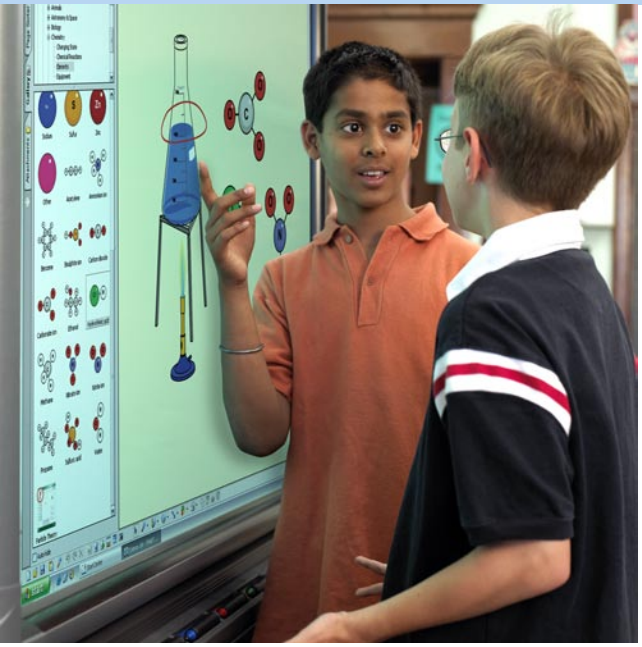
Development of Content

We are not only educators but developers as well. The prospects we see are tremendous, not only by using the included content, but by developing our own. We are aware of the curriculum (Cyprus Education), and we intend to develop content especially suitable for our children.

In the next few months we shall begin developing content using Macromedia/Adobe Flash mostly, a format supported by the SMART board. This will be made freely available from our website (www.apoplous.org) as .swf and .fla files).

Editor's Notes

We are moving towards the end of the school year (2005- 2006). We are pleased to note that we have exceeded our expectations and we are looking at the year ahead.



When you start a project or a research, you must have your ideas in the future and your feet firmly on the ground. This is how we started our research on Thin Clients, and now we are moving towards our 'Classroom of Tomorrow' initiative.

The IT factor

Obviously one of the most important parts of any research is the actual content and how you deliver it. This is something we have been elaborating ever since we started, and at this point we can say for sure that we have done away with most -if not all- our technical issues.

At the end of the day, it is not important what type of machine we use in the classroom. We could say that it is not important what kind or type or brand of whiteboard we use, as long as it works the way we want it to work. After all, when you use a market to write on a normal whiteboard, you don't quite care of the brand, as long as the colors are vibrant and their is enough juice in there to get you going.

It is with great pleasure (and considerable pride) that we received emails from Greece congratulating us on our research and at the same time opening prospects of collaboration. At the same time, it is saddening to note that things are beginning to slow down as far as interest by teachers for the implementation of IT in education is concerned. Teachers need to understand the benefits of technology when it is used properly. Our role is quite different when we use a technology- rich environment. We are no longer the center of the (learning) universe but rather we become part of the experience. And it can become quite frustrating, it requires much more work, and at times it can drive you to exhaustion.

But, when I see my students being engaged in the actual process, it is then that I realize the rewards that come with the 'package'.

After all, if we aspire to take education to the next level, we have to first prepare ourselves for change. And change means a complete 'about face' in how we perceive knowledge.

It is true that we have taken some bold steps forwards (our entire system). But, this is not enough. We have to build long-term strategies and even re-educate teachers on how to correctly use technology. Because, sadly to say, in my humble opinion, the way teachers are learning to use technology is not only insufficient but offers a lot of drawbacks.

My intention was to devote this entire issue to Teacher Training and eLearning in general. However, I reserve that for issue '8' of the OpenEducation Report where I shall introduce the model of Learning Objects for Teacher training using the Lotus LMS and -at a lesser extend- Moodle.

- Alexandros Kofteros
  B.A. Education
  Post-Graduate student, Univercity of Cyprus,
  Curriculum Content Development

For all your comments please feel free to email me alexandros@apoplous.org

If you found this newsletter interesting please forward it to other people. Thanks!