

# Educational Multimedia Taskforce



## SCHEMA

# Report on Network Computer Technology

## Interim Report

**Simon Booth**

**More information about the Schema project can be found under  
<http://www.stir.ac.uk/schema/>**



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## Executive Summary—Interim Report on NC Technology

Because at present it is impossible to deliver the full-range of SCHEMA courses using NC technology over a modem or ISDN connection, SCHEMA's current users are accessing the learning materials using standard PC hardware from either their homes or workplaces. SCHEMA plans to continue using standard PC hardware to deliver our courses, but to use MetaFrame (as originally) specified in the project proposal.

SCHEMA plans to continue investigating the NC solution but shift the emphasis to finding a viable NC solution for future projects. Therefore we plan to conduct some research on finding a suitable NC solution. If time allows, we would use this with students taking SCHEMA modules.

We have continued working on our NC-based "Schools Project". This is a project to equip local schools with networks of Ethernet NCs running off NT servers. This project dovetails elegantly with the UK government's National Grid for Learning. The University has also provided SCHEMA with additional funds to purchase equipment for this project. The details of this project are given in Appendix B.

The remainder of this report explains the background to the technology decision.



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## 1. Introduction

A distinctive feature of SCHEMA is our belief that Network Computers (NCs) or other similar set-top boxes have an important role in delivering Web access to users including those who wish to use the Internet for study purposes. We have always believed that the NC offers a more reliable and easy-to-use computing platform than either IBM compatible personal computers or Apple Macintoshes (hereafter the term PC will be used to refer to both types of machine). We should recall that SCHEMA's target user group of Health, Education and Welfare workers have shown reluctance to engage with computer technology in the past (see also the training needs analysis: Timms et al 1999).

### NCs: Benefits

NCs offer a standard environment that PCs do not. Anyone who has run a Web-based course will have noted that there are differences in how pages are presented in the “same” browser on each of the two platforms—the fact that there are many different versions of each browser only compounds this problem. The problem can also be made worse by the fact that pages do not display correctly: in extreme cases this may mean that some students are unable to access parts of the course. By deploying NCs to all that wanted one (at least in the early stages of the project) SCHEMA planned to solve this problem by fixing the operating system and browser: we would know exactly what platform our pages would be displayed upon.

With SCHEMA's learning approach being heavily biased towards collaborative forms of learning it is important to ensure that students can exchange information easily. Unfortunately, this cannot normally be guaranteed, as different students will use different word processors, spreadsheets and email systems. Converting all documents into HTML could deal with these problems, but the conversion process represents an unnecessary task for the course participants. Many would probably find the process confusing and fail to appreciate why they had to do it. Again, SCHEMA planned to solve this problem by providing a standard set of productivity and communications applications on the NC.

NCs are considerably easier to set up than a PC: all they require are power, telecommunications access and a suitable display device. Once these components have been connected the user simply inserts their Smartcard and PIN. The Smartcard contains all the information necessary to log on to the Internet Service Provider (ISP), validate the user and then display the user's home page.

NCs are also easier to maintain than traditional PCs. The main reason for this is that the user has very little control over the NC and cannot add new software to the machine—a major source of problems when supporting PCs. All software is made available from the server and the server manager is in control of what software is mounted on the server, and which users can access and make use of that software. This does limit what the user can do with the NC. We feel this is a reasonable trade-off to ensure that the NC provides a stable platform. For this reason, it is perhaps better to view the NC as a targeted computing device rather than a general purpose computing device. Its function is to allow the students to collaborative and engage in learning.

## NCs: Problems

The main problem that SCHEMA has encountered with the deployment of NC technology has been our chosen supplier of NC hardware: Acorn Computers PLC (now known as Element-14). Acorn was a major supplier of PC type hardware in the UK market over a number of years. They built their own range of machines running Acorn's own operating system RISC-OS. The simplest way to characterise Acorn is as a British Apple. A company that is innovative but fails to gain significant market share. Like Apple, Acorn has been successful in the UK education market place, not least because of significant government support for their products. Acorn's embracing of the NC seemed an excellent strategic decision for the company. The NC has obvious benefits with education because of its low-cost and high-reliability.

Acorn was a key player in the early stages of the NC design and built the first NCs available in the British market place—these were what Acorn termed “technology demonstrators”. These NCs came in modem and Ethernet variants running NC-OS (a simplified version of RISC-OS) with a built-in Web browser and Word compatible word processor. Acorn could supply an ISDN card for the NC but these were hand built and purchase was prohibitively expensive. The weakness with these early machines was that neither JavaScript nor Java was supported. Java support was quickly added in the form of a 0.5Mb download making it difficult to use over a modem! Over Ethernet the Java technology worked flawlessly. A further weakness with these early NCs was the lack of support for many standard browser plug-ins: Real Audio, ShockWave, PDF, etc.

The early Acorn NCs showed the promise of the technology but did not deliver a viable platform for SCHEMA, as ProTo requires JavaScript to function and TELSIpro uses Java for its chat and edit functions. Abandoning the chat and edit features (over a modem) meant that TELSIpro could be successfully used. The edit function is not needed as TELSIpro has a forms based mechanism to create simple documents but the absence of a chat faculty was more serious. Both Proto and TELSIpro have built-in email systems and so provide access to email for the NC user. The Acorn NC had no built-in email client.

Acorn continued developing the NC until late 1998. The major change was the ability to boot the Ethernet model from an NT server. The software provided for the NT server (TopCat) also provided a RISC-OS like interface. TopCat is an excellent product and came with an ICA client built-in to access a MetaFrame server (MetaFrame is described in D2.2 and further information is available at <http://www.citrix.com>). This Ethernet based NC does meet SCHEMA's requirements but no modem or ISDN models were or are planned. A modem version was never a candidate due to the size of the files that TopCat downloads to provide the RISC-OS interface. It is the Ethernet version of the NC that is at the heart of the “Schools Project”. The TopCat/Acorn NC combination offers a wide range of software as this combination can run a large percentage of RISC-OS software and provides an interface familiar to those who had used RISC-OS—this includes a high percentage of UK based teachers.

In early autumn 1998 Acorn unexpectedly and abruptly withdrew from the NC market place to concentrate on digital television. No further development of the Acorn NC is planned by E-14, the successor company, but they do still license the NC reference profile. When Acorn withdrew from the market they placed SCHEMA in contact with one of the companies that had licensed the reference profile: Funai



Corporation. Funai have developed an NC, which in Europe is being sold, in the first instance, in Sweden. A full report on this NC is given in the next chapter. This is a modem based NC that offers a browser (HTML 3.2), Java (1.02) and JavaScript support and inbuilt security functions but no additional applications. Funai are targeting this model on the home shopping and banking markets (and so do not require additional applications). Like the Acorn NC, this machine lacks support for a range of popular plug-ins. Funai are planning a modem version with a built-in ICA client. We are currently keeping in close contact with Funai.

Other interesting developments are Microworkz's iToaster and the Wyse Winterm 5000. Details of these products are given in later chapters. A review of the Wyse product is also included.

### **SCHEMA Network Device**

SCHEMA is based on a social constructivist view of learning. Its primary target is Health and Welfare workers in remote areas. Any device to be used to support continuing professional development under these conditions needs to possess the following characteristics:

- Easy-of-use and maintenance
- Internet access
- Personal Productivity tools (word processor, spreadsheet, etc)
- Browser
- Email
- Low cost

### **Future Technology**

In the short term there is no obvious NC candidate solution, although in the medium term the Funai NC with the built-in ICA client looks promising. At first glance, there appear to be many NCs available that meet SCHEMA's requirements, but almost all require Ethernet: a technology we are unlikely to find in the average SCHEMA student's home environment. Sun's JavaStation, HP's NetStation, IBM's Network Station and NCD's ThinSTAR family are all Ethernet products.

### **Summary**

At present, SCHEMA is using standard PC hardware (a benefit of sticking to standards) on the two courses currently running and in those planned for 1999-2000 (both learning environments are being used).

We have experienced the problems noted in the introduction. To resolve these problems, we plan to offer MetaFrame client access for future students: this means we can control the version of the browser used by students and more importantly offer a standard (for the course cohort) set of applications. With a standard set of applications we can ensure that materials created by one student can be read and/or

modified by another. This approach fits with the plans laid out in the original project programme.

The one feature of this approach that might cause anxieties in Europe is the cost of telephone calls. When using MetaFrame the client computer must remain connected because the applications are running on the remote server not the local PC. These costs in reality are not unreasonable. Taking the UK, for example, and assuming ten hours on-line per week split 50%-50% between weekends and week day evenings, and taking advantage of discount packages widely available in the UK, would lead to a weekly costs of €10. Not an enormous sum if journeys to and from some local campus are no longer necessary but nevertheless a cost. Free local telephony would certainly reduce costs. At present, in the UK one ISP is offering free access (via an 0800 number) at weekends. A continuation of the trend would be most welcome.

We would be unhappy to abandon investigation of the NC approach—because the possibility of the NC being an inexpensive device offering MetaFrame client access is appealing. Ultimately, an NC with the ability to offer the range of software for SCHEMA without recourse to MetaFrame type solutions would be our preferred solution, although this looks unlikely at present. Future SCHEMA courses will offer students the option of using MetaFrame access to SCHEMA learning resources. The use of MetaFrame means that SCHEMA can achieve one of its key technology goals—a consistent user-interface, consistent presentation of web based materials and a consistent set of applications. MetaFame can be delivered on standard PCs, Macintosh, UNIX workstations, and WindowsCE as well as NCs.

## 2. Evaluation of Funai NC

### Introduction

The target market of this device is home banking and shopping. Much of Funai's marketing revolves around its strong security features (ID2), making the unit ideal for home banking and secure e-commerce.



Figure 1: The Funai NC

The unit is sold as a set-top box with an IrDA (Infra-red) controller. A standard keyboard and mouse can be attached. IrDA keyboards can also be used (just like the Acorn). The unit is connected to the TV/VGA monitor, phone and power and is ready to go.

Unlike the Acorn model, the Funai does not have a word processor included in ROM (other useful items are—see later). The administration interface is much cleaner and more attractively designed than the Acorn. The user details are entered interactively and stored on a Smartcard. Alternatively a fully configured Smartcard can be supplied to the end user—the preferred option for the naive user as they simply slip in their Smartcard and enter their PIN. The details stored are ISP, username and password and up to five email addresses.

An optional ICA client will shortly be available for the Funai. This coupled with a MetaFrame server will provide a full Windows NT interface on the Funai NC over a modem connection. At present only the modem version is finished but for SCHEMA this is ideal. Funai are working with Doro AB and the University of Lund on an Ethernet version. For further details of ICA and MetaFrame see the Citrix Web site: [www.citrix.com](http://www.citrix.com) or SCHEMA deliverable D2.2 (Booth 1998).

An interesting and potentially key feature is that the Funai unit can be software upgraded over the phone line. We were unable to test this but this is a potentially useful feature for SCHEMA.

### SCHEMA and the Funai NC

SCHEMA uses two different Web based learning environments: ProTo and TELSIpro, both developed by the University of Oulu, Finland. TELSIpro worked successfully with the Acorn NC although using the Java components of TELSIpro would require a 0.5Mb download of the Java Virtual Machine. Over a modem this is

an unrealistic expectation but is no problem over Ethernet. ProTo does not work with the Acorn NC as it uses JavaScript and the Acorn NC does not support JavaScript.

The Funai NC having both JavaScript and Java built into ROM seems a much more promising prospect for SCHEMA. Again, TELSIpro worked well with the NC although the new Java editor does not work as this requires support for the 1.2 Java API and the Java onboard the Funai is 1.02. The Chat applet worked well.

ProTo experienced similar problems to those already encountered on the Acorn NC. The login page appears but after entering a correct username and password the user is returned to the login screen. Proto requires that the client machine supports cookies and does not cache the Proto pages. The Funai supports cookies (they are lost when the unit is powered down). The problem is with the caching. Proto depends on its pages not being cached on the local machine. The mechanisms that are used to achieve this are various HEAD element tags that specify that the pages must not be cached. These elements are defined in the HTTP/1.1 standard that has yet to be agreed. As Funai only claim to support HTML 3.2 there is no requirement that it supports these caching elements. Presumably it does not support these tags and the pages are cached. Once the pages are cached ProTo will fail to function.

### **Features of the Funai NC**

Main features:

- The Funai machine has a built-in POP3 email client that allows off-line reading of email. This was successfully used with both the University's email service (Microsoft Exchange) and the service offered in the UK by Tesco. Up to five email accounts can be defined per Smartcard. The mail system indicates when there is email waiting after the user has dialed-in. There is an option to dial straight into email.
- Built-in HTML 3.2 compatible browser with full frames support. Favourites/bookmarks can be defined. Supports SSL2.0/3.0 (40 bit encryption).
- Java 1.02 and JavaScript 1.1 are built-in. (More precisely the Scriptease ([www.nombas.com](http://www.nombas.com)) interpreter for JavaScript.)

Multi-Media:

- AU, AVI, MOV, WAV.
- Neither Shockwave nor Real Audio are supported.

Specification:

- ARM 7500FE
- ROM: 8Mb Flash; 4Mb ROM
- 16Mb RAM
- Modem: 33.6 (controller less)
- OS: RISC OS NC2

## Using the Funai NC

Upon startup the unit offers four choices:

Connect, Email, Smart card, Options

**Connect:** connects with the ISP defined on the smart card. If more than one email account is defined then the account to be used must be selected. The connection process is neatly represented to the user. Each stage dialling, connecting and verifying is clearly indicated.

**Email:** opens the Inbox, which allows the off-line composition of email. Connection can also be established from within the email screens. An advanced Inbox button gives access to forward and delete features. It is a pretty basic email system but does have the benefits of being easy to use.

**Smart card** configures the Smartcard. The user can change the ISP and PIN number. To configure the ISP a phone number, username, password and URL are defined (the URL is for the user's welcome page). Next some additional technical information is required: ISP domain name, primary and secondary DNS. A default modem dial script is provided. Lastly to configure the NC for net usage: time, SMTP and POP servers are defined. Up to five different email addresses can be configured but they must all be with the same ISP. This would allow most families to give each member a personal email with username and password.

**Options:** User definable features are: text size and scaling; printer set up; screen display (not used to select resolution and refresh but to centre the picture when used on a standard television); sound on/off; dialling options; disable call waiting.

## Browser

Unusually the buttons for Home, Back, Forward, Goto, Email, Favourites, History, Info and Refresh are presented along the bottom of screen. The centre button on the mouse can be used to toggle this display and obtain a larger display area for web pages. If the user has email, an icon appears amongst these buttons indicating that there is unread email. As with PC browser, animations are provided indicating that the page requested is being downloaded. (This icon is also the refresh button).

The browser works perfectly well displaying pages that conform to the HTML 3.2 specification.



### 3. Wyse Winterm 5000

Wyse have been manufacturing terminals since 1981. In recent times the company has concentrated on NC like devices with its Winterm range. There are three product lines in this range: 2000, 3000 and 5000 (the 5000 is the most recent). Both the 2000 and 3000 series are based on Ethernet networking technology and both support ICA and RDP. RDP is the Microsoft variant of ICA (RDP stands for Remote Desktop Protocol) and requires the Microsoft Terminal Server to serve applications. RDP does not offer as many features as ICA. For instance, RDP does not support printing via the client machine or sound.

The 5000 series is much more interesting from a home users prospective because whilst it does support Ethernet connectivity, it can also use PPP or SLIP over a modem connected to one of its two serial ports. At the first release, SLIP does not support ICA and so the connection must be PPP to support ICA.



Figure 2: Winterm 5000

The 5000 does not have RDP but ICA is retained. The 5000 series also has a local operating system (as does the 3000 series: Windows CE) that supports a browser (derived from Netscape) which is HTML 3.2 compliant and supports JavaScript 1.2, XML and DHTML. Support for both POP3 and SMTP email is also built-in. The operating system used is Linux. Although the 5000 loses the RDP support it gains X11R6 and AIP (SCO Tarantella). This machine is designed to provide terminal services to both Windows NT via MetaFrame and UNIX via X. It can mix these environments on screen at the same time so that both X and Windows applications can be handled simultaneously.

#### Specification

- Linux (in ROM as there is not a harddisk)
- CyrixGX Media Processor (x86 compatible)
- Two serial ports
- Parallel port
- 10Base-T
- PCMCIA slot
- Remote dial-up via external modem

Java is available via the server (i.e. the UNIX system serving X or the NT server running MetaFrame) and will be added to the local configuration in the future.

The cost of these Wyse products is likely to be higher than SCHEMA would like. We anticipate a UK listing at £800 ex VAT. The 5000 series is also a richer machine in many ways than SCHEMA requires. The X support is unnecessary and given that ICA is present there is no need for a local browser and email. The built-in Ethernet support also is not needed, indeed a built-in modem would be better.

The presence of Linux is encouraging as this means that some SCHEMA configuration may be possible using the wide range of applications available for Linux.

### **Winterm 5000**

SCHEMA sourced an evaluation machine from Wyse UK. This machine was available to us for a little over a week but this was sufficient to investigate what the machine offered to SCHEMA.

When the machine starts-up it can either immediately join the network via DHCP (provided an Ethernet connection is present) or delay this until a dial-up connection is established. The machine as configured can do little without a network connection, as the only local applications are a Web browser and Email client. A terminal application is present to access machines providing Telnet connectivity. The picture below shows the Winterm5000 running Netscape via an X-session (the X-Manager can be seen in the background), the native email client and using a Windows NT server via MetaFrame.

The built-in browser can in principle support ProTo because it has JavaScript and TELSIpro (with the Java components). In practice, usage is poor. The browser can logon to ProTo and navigate successfully but when working through the materials in the library fails to display the actual text! With TELSIpro the problems are worse: the frames are incorrectly updated and the interaction between the browser and server generates errors from the server. We suspect that this is because the browser is the first release (it is based on the Netscape code but with much removed to make it small enough). The browser cannot be used with ProTo or TELSIpro. Of course, we can use either ICA or X to access browsers written for either NT or UNIX to solve this problem.



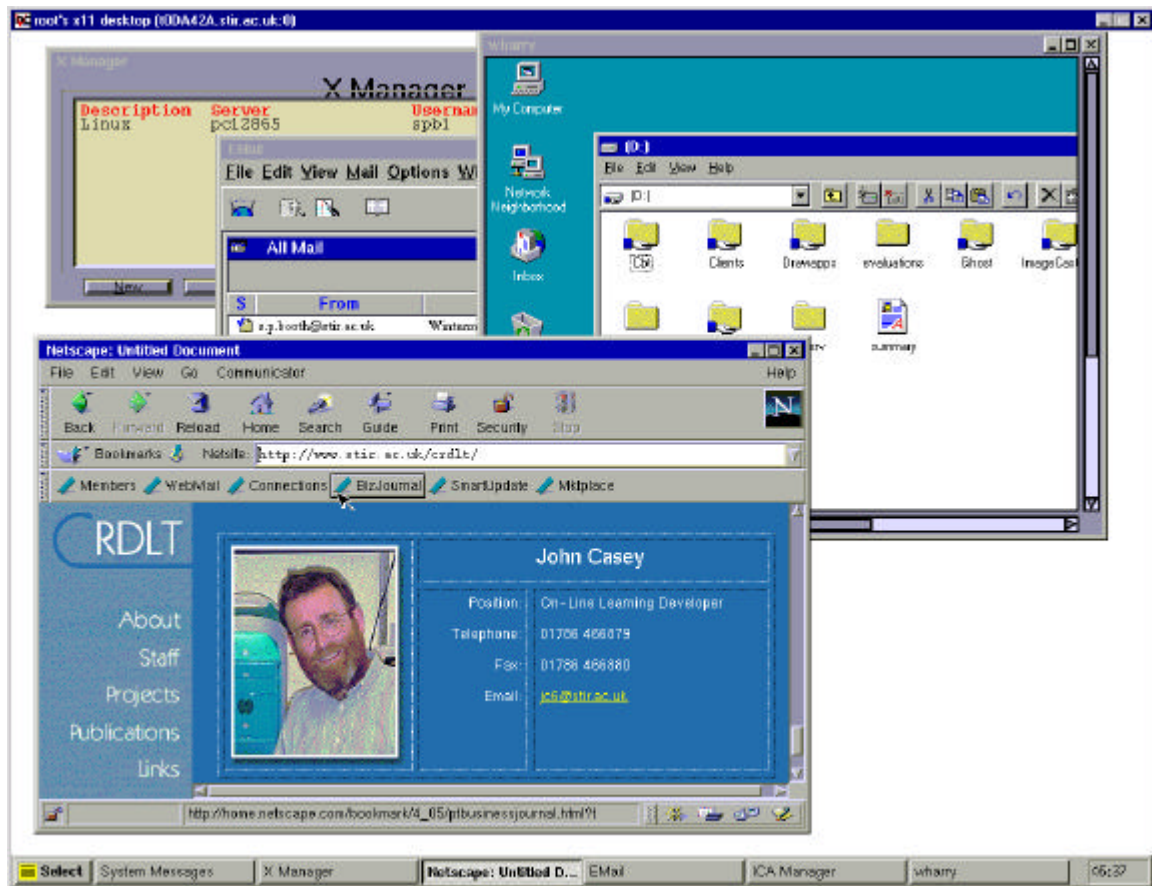


Figure 3: Winterm 5000

The main problem with Winterm 5000 is cost. A “proper” PC can be purchased in the UK for €650 or less. Both Tiny and Time currently offer packages involving telephony or Internet access where the PC is provided free. As stated earlier, we anticipate a UK cost of €800 for the Winterm. It would be cheaper from SCHEMA prospective to provide real PCs plus applications and use MetaFrame to act an application server: this is an approach where applications that cannot be installed on the local PC (for whatever reason) are provided using a MetaFrame server (where the application is installed). This is an attractive approach as it limits the phone costs to when either the Web based resources for a course are being accessed or a specialised application is being used. The phone costs are associated with performing everyday tasks like word processor and running spreadsheets.



## 4: iToaster

This machine is currently only available for the US market and is priced at \$199 (~€200). The machine was only released in the US on 15<sup>th</sup> July 1999. The manufacturer is Microworkz (<http://www.microworkz.com>). The specification is given below:

- 200 Mhz Intel Pentium Processor
- 3.2 GB Hard-Drive
- 32Mb RAM
- K56 v.90 fax/data modem
- Multimedia Keyboard and scroll mouse
- Instant On/Instant Off
- One-click Internet Access
- Ports for printer, scanner, USB
- VGA port (support for 800x600 at 16M colours)
- TV Out (additional \$29.95)

The operating system is a mixture of Linux and BeOS. Further details are not currently available. A screen shot (taken from the Microworkz Web site is given below):



Figure 4: The iToaster Screen

A careful examination of the above screen reveals that a browser, calendar, email and word processor are included. The browser is roughly equivalent to Internet Explorer version 3. Microworkz are planning to support Real Audio/Video and Shockwave (these are very useful browser plug-ins, especially Shockwave). As the machine is being sold for Internet access we assume that it supports Java and JavaScript but

cannot confirm as there are no details on the Web site. Having Java support would be sensible as this makes a wide range of software available on day one. Linux does have Java Virtual Machines but BeOS does not so the iToaster may or may not have support for Java. Details of the word processor are again not available at the time of writing.

The machine has a hard disk and is only used to store the operating system, applications, user files and cached files. The user cannot add applications.

From SCHEMA's perspective this is an interesting machine. Unfortunately the US only status means that we cannot obtain one for evaluation (the modem will not function in the UK). The use of Linux/BeOS for the operating system may mean that standard Linux/BeOS applications can easily be added making it straightforward to add applications for SCHEMA's use. Equally, the user interface has been designed to be as simple as possible as can be seen by the screen above. Clearly the user simply clicks on the relevant icon to gain access to that application. There is not an ICA client available for this machine but as this machine has the ability to support local applications this is no particular problem. Indeed, the machine may be more flexible in terms of local application support than either the Acorn or Funai NC. Local applications on these machines have to be supplied in ROM and would be hard for SCHEMA to add without the manufacturer adding them on our behalf. With the iToaster, it may be possible to add our own selection of applications to the hard disk and then make them available via the standard interface.

We will certainly be very interested if Microworkz choose to launch a European model. Clearly the machine's success (or otherwise) in the US will influence this decision.

## 5. WebTV

Currently only available in the US, Canada and Japan, WebTV is a Microsoft owned service that comes in three flavours: WebTV Classic, WebTV Plus and WebTV Plus for Satellite. The main difference between the Classic service and Plus is that the Plus offers more TV based features (picture in picture, interactive TV links, searchable TV listings, reminders one minute before a certain TV programmes are broadcast, and VCR programming). The Classic service offers straight Internet access and Email. The satellite service offers everything in the Plus along with the ability to pause a TV program for 30 minutes (the support unit has an 8Gb harddisk fitted), games and parental control. What is most interesting to SCHEMA are the set top boxes used to support the Classic and Plus services—the boxes are manufactured by Sony, Philips and Mitsubishi. The Classic service uses an “Internet Terminal” and the Plus an “Internet Receiver”. The difference between the two types of device are that the terminals are lower powered devices (slower processors, less memory) and do not support the additional TV features. Both types of box are reasonably well-specified NCs with:

- MIPS processor
- TV out
- HTML3.2
- Real Audio 1.0, 2.0, 3.0, .AU, .WAV, Shockwave Audio, QuickTime Audio
- JavaScript 1.2
- Flash 1.0, 2.0
- Parallel port
- 56 Kbps V.90 Modem

There is no information about the OS on the manufacturer’s Web sites but Microsoft’s involvement and the presence of a MIPS processor strongly suggests Windows CE. A Java Virtual Machine has been recently released for Windows CE, so Java support is probably available. Windows CE does lack support for a number of popular plug-ins: Flash and PDF spring to mind. The pricing is very attractive with the terminal priced at €99 and the receiver at €199.

In the UK, Sky’s digital television service launched BiB (British interactive Broadcasting) on 22<sup>nd</sup> August. The first service is interactive football: the viewer can choose items like the particular camera to view from and request action replays at any point. Additional shopping and banking services are also planned making this similar to WebTV. The biggest difference is in the set top boxes. The Sky Digibox lacks printer support and the service offered by Sky does not include full Internet access (although email is planned). Sky’s package is very similar to WebTV except that Internet access is not currently planned.

Both the WebTV and Sky Digibox devices do not have a standard VGA out connector. They can only display on a television. Clearly the lack of Internet access on the Digibox is a complete showstopper at present for SCHEMA although we have made connect with Sky in the UK to investigate what can be done with BiB.

WebTV itself would be an interesting avenue for SCHEMA to explore but the absence of any European service makes this impossible at present.

### **Set Top Boxes (Background)**

The growth in “set-top” boxes in the UK spurred by the introduction of digital television has been fast. It is now estimated that around 1.1M homes in the UK have a set-top box to receive digital television (in July 1999).

Digital television is racing away, according to the well-respected city analyst Matthew Horsman at Investec Henderson Crosthwaite. He says that BSkyB has attracted about 900,000 subscribers of which more than 250,000 are new Sky customers. Horsman had also predicted that ONDigital had passed 240,000. This is confirmed (8 July) with the announcement from Queenstown Road that the terrestrial broadcaster has signed-up a total of 247,000 subscribers - a record for the launch of a digital television service in Europe.

(<http://www.dtg.org.uk/> 15<sup>th</sup> July 1999)

The same source ([www.dtg.org.uk](http://www.dtg.org.uk/)) predicts a total of 2M subscribers by the end of the year. This means that 2M UK households will have an NC sitting in their living rooms by the end of 1999. This is a large potential market, particularly for those wanting to provide consumer services on the Internet. These boxes can equally well be used to deliver learning, along as they have the features to deliver on-line learning environments or on-line learning environments are re-designed to work with these set-top boxes. The most likely route as present would be re-designing the learning environments to fit the Digibox as the Digibox works best with sites designed to work it. The lack of a printer port on the current generation is a concern although as the connection service (not ISP as Internet connectivity is not part of the picture) is free via a 0800 number—this will keep on-line costs low!

## 6. Conclusions

Before comparing the various devices discussed noted above, we should lay down a technical specification required to support SCHEMA's vision of collaborative learning.

- Web browser capable of supporting ProTo and TELSIpro. This means that Java 1.2, JavaScript 1.2, HTML 3.2 are all supported. The browser must be capable of handling cookies and not cache pages when requested not to do so. Email support is needed for ProTo. TELSIpro has an internal email system.
- Plug-ins: Flash, PDF, Real Audio.
- Local applications. A minimum of a word processor and ICA. ICA allows SCHEMA to be an applications provider for any additional applications required by a particular course.
- Machine is sealed unit that allows no local user configuration except the ability to re-program a smartcard with new ISP details etc.
- Software upgradeable via phone
- ISDN connectivity
- Video

Software	HTML3.2	Java1.2	JavaScript1.2	Cookies	No Caching <sup>1</sup>	Flash	PDF	RA	Apps	ICA <sup>2</sup>
Funai	✓	1.02	✓	✓						
Wyse	✓		1.2	✓	✓					✓
Microworkz	✓	Unknown				✓		✓	✓	
Acorn	✓	Download		✓					✓	Download
WebTV	✓		✓					✓		
PC <sup>3</sup>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

<sup>1</sup> No caching means that the browser will obey when instructed not to cache certain pages.

<sup>2</sup> Flash, PDF and Real Audio can be supplied via the ICA client but uncompressing both the Flash & Real Audio on the server and attempting to transport to the client over a modem can cause bandwidth problems (especially if any video is present). Java support can also be obtained via ICA.

<sup>3</sup> Comparative purposes only

Software	Sealed	SmartCard	TV	Software Phone	ISDN	Video
Funai	✓	✓	✓	✓		
Wyse	✓				✓ <sup>4</sup>	
Microworkz	✓		✓ <sup>5</sup>			
Acorn	✓	✓	✓			
WebTV	✓	✓	✓	✓		
PC			✓ <sup>6</sup>		✓	✓

For the moment we are forced to exclude the iToaster as there is no European version of this device presently available. This is unfortunate since this device meets nearly all of the specification given above for SCHEMA (as long as both JavaScript and Java are present). The iToaster is low-cost, easy-to-use, has Web access and email, and local applications (word processor, spreadsheet and graphics). Add to this the support for Real Audio and Shockwave and the only feature missing is ISDN connectivity and video conferencing support.

After the iToaster, the Wyse machine is closest to SCHEMA's requirements because it can run ICA over a modem but the cost is prohibitive at €300 plus the cost of an external modem and monitor (the Wyse only has standard VGA output). This makes the likely price around €1000. If the approach it offers were to be taken up (i.e. access server based application using MetaFrame) then providing PCs would be a less expensive way forward. The Tiny free PC offer entails guaranteeing spending £25 on telephony (excluding line rental) per month for a year. So if an individual is already spending in excess of this amount they can in effect obtain a PC for nothing! The Winterm is targeted at a different market. Wyse have a reputation for building high-quality terminal devices and the 5000 series we have no doubt will be successful in its target market but this market does not include SCHEMA (unless the price is reduced by something like 50%).

Next best and at around €300 reasonably priced is the Funai device. It supports both Java and JavaScript: this means that it should work with both TELSI and ProTo. As mentioned earlier, the Java editor (due to API differences) does not work in TELSI and ProTo failed to work with the Funai NC. The lack of on-board applications is a concern for SCHEMA. Our users require access to at least a word processor. Spreadsheets, Database and Graphics packages may also be useful but we have to recognise that ROM space is limited! The optional ICA client appears to offer a means to solve all the problems listed above and we await with interest Funai's announcement of a machine that supports ICA. The Acorn NC has an ICA client but

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<sup>4</sup> Via external TA (extra cost)

<sup>5</sup> Additional \$29.95

<sup>6</sup> Additional Cost



had to download the client and this took sometime (over a modem) as the file was 0.25Mb. Acorn did intend to produce an NC with a built-in ICA client but this never got further than a specification, the so-called "DeskLite". Boca Research in US built a DeskLite specification NC for the American market but have no plans for European distribution.

Funai see their core market with this device as a "set top" box offering home banking and shopping services. Funai's marketing presentations particularly emphasise banking. They claim that 80% of European banks will provide full electronic banking services within three years. Funai claim that over the counter transactions are 100 times more expensive than electronic transactions. Also banks are keen to promote themselves as innovators in order to attract and retain customers. Whilst home banking is not SCHEMA's game, NCs are, and designing learning environments that can function on NCs offers a huge potential market if home banking and shopping takes off using NC technology for a significant proportion of its users. The NC will be helped if deals with ISP are struck that lower the cost of owning the technology. The sort of package that might be offered is with an ISP offering 12 months access to their portal at £50 but the ISP providing the NC as part of the package. Virgin and Freeserve (both UK based ISPs) are known to be looking at deals of this type.

The Funai machine's Web browser's lack of plug-ins and support for the more recent versions of HTML will mean that many sites simply do not display properly. This means that in all probability the unit cannot be offered as a web browser at low-cost using a TV as monitor but as an access point to sites with Web pages designed to suit the unit (and display correctly on a TV as opposed to a "normal" monitor). The site designed by Telia (in beta at the time of writing) certainly works very well with the NC.

The market for NCs and NC like devices is very dynamic with new products appearing regularly. In 1999, we have seen the Funai NC, the iToaster<sup>7</sup> (US only), the Winterm 5000 along with the Sky and ONDigital set-top boxes all presenting different solutions to providing computing power in the home (or workplace). None are traditional PCs, yet most offer the possibility of accessing the Internet and accessing on-line learning.

Broadly speaking these devices can be categorised into three types:

- Home Entertainment: WebTV, SkyDigital  
Basically designed to add value to television by providing additional services (Internet in the WebTV model and shopping/banking with Sky). Both designed to provide "interactive TV"
- Home Computer/Thin Client: Funai, Acorn, Microworkz  
These are the devices for SCHEMA. Designed to provide low-cost, easy-to-manage computing in the home. Have built-in modem and ideally can have the software upgraded over a modem.
- Corporate Thin Client: Wyse, Sun JavaStation, HP, IBM  
Sold as Ethernet devices offering computing for the lowest TCO (total cost of ownership) and very effective in situations where a well defined set of applications need to be delivered to the desktop.

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<sup>7</sup> It is rumoured that the ISP freeserve is negotiating with Microworks for UK production of the iToaster.

None are perfect from SCHEMA prospective but the market is moving in all sorts of interesting directions. One that has only been mentioned in passing is WindowsCE. WindowsCE is a cut-down version of Microsoft's Windows (95, 98, NT) range of operating systems. It is designed to run on hand and palm style machines but has also been used by Wyse in their Winterm 3000 range and we suspect the Web TV set top boxes. The handheld devices that currently use WindowsCE (HP's Jornada 820, NEC's 800, and many others) offer an attractive range of features: reasonably large screen's, built-in modems, a set of lightweight built-in applications, Web browser and Email client—everything that SCHEMA's needs including an installable ICA client. The key feature with these class of devices is that they are designed for portability (usually with very long battery life's) and only offer "good value" when compared with standard portable PCs. For instance, the UK price of the Jornada 820 is €100. They also suffer from the same problems as portables: small keyboards, touchpads and compared with a standard PC monitor small screens. If portability was a major issue this type of device would be very attractive with their long battery life's, low-cost and light weights.

One strategy that would be worth investigating for a future project, would be to re-engineer or design from the ground up a learning environment to work with a particular set-top or group of set-top boxes (Digibox's or Web TV or other). The set-top must offer a sufficient powerful set of features but with the potential growth of digital TV across Europe this is clearly a sensible approach. For SCHEMA, re-engineering ProTo or TELSIpro is not a possibility: there is not sufficient time and neither was such an approach envisaged in the project programme.

We will continue monitoring the market not for an NC like device for SCHEMA, but for a device that can be used in future project. SCHEMA instead of providing NCs to its users will be an application provider via ICA/MetaFrame. This way we can make our users learning much more straight forward as we will manage the complications of any specialized packages or complex software installations on their behalf. The users should be able to concentrate on their learning and not the vagaries of PCs and the software they run.

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### URLs

Acorn	<a href="http://www.acorn.co.uk">www.acorn.co.uk</a>
Apache	<a href="http://www.apache.org">www.apache.org</a>
British Interactive Broadcasting	<a href="http://www.bib.co.uk">www.bib.co.uk</a>
Citrix	<a href="http://www.citrix.com">www.citrix.com</a>
Doro	<a href="http://www.doro.se">www.doro.se</a>
Funai	<a href="http://www.funaiusa.com">www.funaiusa.com</a>
Microsoft	<a href="http://www.eu.microsoft.com">www.eu.microsoft.com</a>
Microsoft NT	<a href="http://www.eu.microsoft.com/ntserver">www.eu.microsoft.com/ntserver</a>
Microworkz	<a href="http://www.microworkz.com">www.microworkz.com</a>
Sky	<a href="http://www.skydigital.co.uk">www.skydigital.co.uk</a>
TopCat	<a href="http://www.microlynx.co.uk">www.microlynx.co.uk</a>
WebTV	<a href="http://www.webtv.com">www.webtv.com</a>
Wyse	<a href="http://www.wyse.com">www.wyse.com</a>



## Appendix A: Funai NC

### Hardware

ARM 7500FE/56MHz  
16 Mb RAM  
4 Mb masked ROM  
8 Mb flash ROM  
VGA port  
33.6 Controller less modem  
Parallel Port  
NTSC/PAL via RCA jacks  
PS/2 keyboard and mouse ports  
Smart Card Reader

### Software

Acorn RISC OS NC2  
JavaScript  
Java Virtual Machine  
HTML 3.2 browser

### Features

Off-line email (5 accounts)  
ID2  
Automatic software upgrades over telephone.  
Citrix ICA protocol (optional)



## Appendix B: Schools Project

This appendix gives the technical background for setting up the schools project. Example configuration files for the NCs and the Apache are presented. Also the educational background for this project are discussed.

Whilst the Funai NC has many attractive features, Funai do not at present supply an Ethernet based model. This is unsurprising as Funai are in the business of supplying NCs for home use, where the most likely type of “network connection” is a standard telephone line. This is one of the reasons why we have employed the Acorn NC for the Schools project—not only does the Acorn machine come in either modem or Ethernet configurations but SCHEMA already has a number of these machines used in the evaluation stage of the project.

### The Schools

Three local primary schools have been selected as part of this Project. Each chosen because of its characteristics and each chosen to ensure that the three local authorities near the University have one school involved. The schools are a small rural school, a large village school and a medium sized village school.

### Equipment/Set Up

The configuration for this project is:

- NT Server with Topcat
- 3 Acorn NC (10Base-T)
- UTP hub
- Router. (This routes between the LAN connecting the server and NCs and the School’s connection to the Internet). A software solution is employed using RRAS (Routing and Remote Access for NT).
- Modem/ISDN TA (one of the Schools involved has an ISDN connection)

We will also add to this set up as many of the schools existing PCs as we can. In the small rural school this will be all the PCs as the school has been fully network by the local authority in preparation for this project.

This equipment is then set up in the following style:

#### NT Server

The NT server runs NT4 SP5 (service pack 5) and provides file and print services to the NCs. The NT server also acts as a BOOTP server for the NCs (this is how they get their operating system). For the BOOTP component to function correctly SP4 should be installed.

Topcat is then installed on the NT server. This automatically adds a username (Armboot) and password to the NT server along with two shares:

- Armboot\$—This is RISC-OS. The \$ on the end of the share prevents anyone browsing the server shares seeing the Armboot\$ share

- Server—Manuals and other useful “odds-n-ends”

Details of the password are found in the file TCCONFIG\User under the Armboot\$ share. This username is employed by the NCs to access the server to obtain the boot files. Once Topcat is installed, the NCs can be statically booted (i.e., they must have a static IP, Gateway, Netmask, DNS addresses and bootfile in their ROM). Alternatively, DHCP can be configured on the server to provide the IP information and bootfile for the NCs. This is the preferred option as NCs can then just be connected to the network, their details entered in DHCP and then the NC can boot. Configuring DHCP is a relevantly straightforward process on the private network (as the Schools will have) but must be done in conjunction with the network administrator on larger networks.

### Private Networks

Private networks can be used by anyone and do not need registering with any Internet Authority. The range of class-A (10.0.0.0-10.255.255.255), class-B (172.16.0.0-172.31.255.255) and class-C (192.168.0.0-192.168.255.255) addresses allocated for private use will not be routed on the Internet. Consequently care should be taken when connecting these networks to the Internet because the machines on them cannot access the Internet as independent machines. Any router, gateway or bridge simply will not forward these private network packets.

We selected the class-C range and have used network 192.168.0.0. The NT server is (192.168.0.1) and the NCs start at 192.168.0.2. The subnet is 255.255.255.0 (so the network supports up to 255 addresses—rather more than we envisage are needed at this point).

The mechanism used by most private networks is to connect the network via some sort of routing device to an ISP. The ISP will then provide a proper IP address for the interface on the router that is connecting to the Internet and that device will handle the LAN-WAN interface with varying degrees of sophistication. About the simplest approach is to configure a machine with an Ethernet connection to the local network and a modem (or TA) to the Internet and then add a proxy server to the machine connected to the Internet. The operating system on the machine must be capable of routing between the two network devices and dialing the ISP on demand via the modem. This allows Internet surfing by all the machines on the local network as long as they use the proxy server to “access” the Internet. The local machines cannot access the network directly. This is our solution for the Schools project as this is available for NT4.

Another solution is to use a routing device that provides Network Address Translation (NAT). In this configuration, the routing interface connected to the Internet has a proper IP address but it translates all the private addresses via this single proper IP address. This means that the network still has only a single routable (or proper) IP address but the each machine on the local network can access the wider Internet via the single IP. Thus all the machines can access the Internet independently. This solution requires the extra expense of the routing device and gives no benefits if Internet access is only required. This solution is built into Windows 2000 but experiments using Windows Beta 3 RC1 experienced problems with the server continually dialing the ISP. This appears to be a bug in this beta release and we expect the shrink wrap to solve the problem. We expect Windows 2000 to be available later this year. For the Schools project we have stuck with NT4 as this is a proper release and it does provide sufficient functionality to start with.



The NCs network set up file is TCCONFIG\setupnet (again under the Armboot\$ share). An example is shown below (configured with Stirling University's DNS and domain name). In RISC-OS “| |” introduces a comment:

```
| | Set network routing
| | (syntax: route -e add net default <gateway> <number of hops to
| | gateway>).
| | On NC OS 1.06, it isn't read by the bootp client
bin:route -e add net default 192.168.0.0 1

| | Set up the name resolver. Replace 136.170.131.2 with the IP addr of
| | your own DNS master. On NC OS 1.06, it isn't read by the bootp
| | client.
set inet$resolvers 139.153.100.7
set inet$localdomain stir.ac.uk
resolverconfig

| | Fix up the netmask. On NC OS 1.06, it isn't read by the bootp client.
bin:fixnetmask 255.255.255.0 1
```

With the above file configured correctly, the NC is ready to access the wider via the Internet Server. Every address we enter that it not on the 192.168.0.0 network will cause the server to call the ISP (unless a call is already established).

Ideally, though, we should provide a local Web server on the NT server so that some Web access can be achieved without the need to dial out (and incur phone charges). The Apache server is ideal for this as it is a widely deployed server solution and is free! The code is not as mature for the Win32 platform as it is for UNIX but has run reliably in our tests (and will improve as the bugs are ironed out).

### Proxying

Having deployed a Web server on the local network in an attempt to make some Web access local and avoid call charges. It makes sense to also deploy the proxy server on the NT server. The proxy server acts on behalf of its clients. The clients use the proxy to access the Internet on their behalf and obtain the requested files. Most usefully, a proxy server will not access the Internet to obtain a requested file if it has already obtained that file and currently has it cached. Thus by using a proxy server, the amount of network traffic is reduced because if NC1 requests file and the proxy does not have it, the proxy will obtain it and serve it to NC1 and keep a copy in its cache. If NC2 now requests the same file from the proxy, the proxy serves from its cache and generates no Internet traffic. This has two benefits: (i) it makes efficient use of whatever bandwidth is available (this is particularly important when accessing the Internet over a V.90 modem when the likely transfer rate downstream is around 44kbps) and (ii) with careful use it is possible to cache whole sites and avoid the need for subsequent calls to the ISP to access. When setting up the proxy under Apache amongst other items the size of the cache and the length of time files are kept are user configurable. We plan to allow a cache up to around 50% of the available disk space after everything is installed with an expiry time of seven days (i.e. the files in the cache will be refresh each week).

Setting up Apache as both a main Web server on port 80 and as a proxy on 8080 is slightly tricky but can be done. A virtual server is defined on 8080 to handle the proxying. A suitable configuration file is given in Appendix C. The browser on the NC is then configured to use the proxy server on port 8080 and the standard Web server on port 80.

It is important to name the main NT server and any other devices on the local network in the hosts file (%windir%\system32\drivers\etc\hosts). If this step is neglected calls to the main

web server have to be given in raw IP format (<http://192.168.0.1/>) instead of the selected name (e.g., <http://schema/>) and without the entry in the hosts file the proxy server attempts to find the name by querying the DNS which causes a call to be made to the wider network!

## Training

The technical component of setting up the networks is just that, a technical solution to a particular computing problem and it ensures that the schools have easy-to-use NCs that make efficient use of whatever bandwidth the School has available. What we must do next is ensure that the equipment gets used. Whilst we cannot guarantee this we plan to provide extensive training for the teachers at each School in the use of the Internet and to draw their attention to good Web sites and resources for teaching and learning.

One external factor will undoubtedly help and that is the UK Government's National Grid for Learning—a major initiative aimed at getting Schools on the Internet (<http://www.ngfl.gov.uk/>). One criticism that can be made of NGFL is that it appears to be focused more on the provision of technology and not the training necessary to exploit the technology. The launch of the NGFL gave the strong impression that access to the Internet was a “good thing”. Whilst we agree, we do not believe that school teachers necessarily share this assumption. Especially as they will gain much information about the Internet from the media and plenty of media coverage in the UK focuses on the less savory aspects of the Internet.

## Conclusions

The simplest way, in our view, to encourage the use of IT within any environment is to place it within some meaningful context. With the Schools Project we have handled all the technical set up issues and will provide in the short term technical support—it will be interesting to see how reliable the various technologies prove to be in the field. More importantly, considerable effort will be expended on training for the teachers and working with them to identify useful learning sites or services on the Web. Too often in the past, Government policy has placed the emphasis on the provision of equipment but not on empowering the users to benefit from the equipment.

Over the next 10 months of SCHEMA (and beyond) we will be following the impact of the technology on each of the three Schools. We are particularly interested, in the first instance, on how the staff engage with the technology and what learning benefits (or otherwise) there are for the pupils. We are sure that the pupils will be engaged by use of the Internet because at the present time in the UK the Internet is almost a fashion accessory. This will pass and then the real value and impact of the Internet will be easier to judge. We believe that both its value and impact will be as profound for teaching and learning as it will be for commerce. The process will be longer for teaching and learning for a number of reasons. Most important is that we should proceed with caution and not be blinded by the latest and greatest technology. Other factors that will slow progress are the conservative nature of the educational profession and that there is less money to be made in this domain.

The Schools Project is a small-scale but significant item of research into the value and impact of the Web on teaching and learning. We have taken every pre-caution to ensure that the technology has been introduced into the Schools as smoothly as possible and that the staff within the Schools have been properly versed in how to exploit the technology.

## Appendix C

Apache configuration file (# for comments):

```
### Section 1: Global Environment
#
# The directives in this section affect the overall operation of Apache,
# such as the number of concurrent requests it can handle or where it
# can find its configuration files.
#
#
# ServerType is either inetd, or standalone. Inetd mode is only
# supported on Unix platforms.
#
ServerType standalone

# ServerRoot: The top of the directory tree under which the server's
# configuration, error, and log files are kept.
#
# Do NOT add a slash at the end of the directory path.
#
ServerRoot "C:/Program Files/Apache Group/Apache"

# PidFile: The file in which the server should record its process
# identification number when it starts.
#
PidFile logs/httpd.pid

# ScoreBoardFile: File used to store internal server process information.
# Not all architectures require this. But if yours does (you'll know
# because
# this file will be created when you run Apache) then you *must* ensure
# that
# no two invocations of Apache share the same scoreboard file.
#
ScoreBoardFile logs/apache_status

# Timeout: The number of seconds before receives and sends time out.
#
Timeout 300

# KeepAlive: Whether or not to allow persistent connections (more than
# one request per connection). Set to "Off" to deactivate.
#
KeepAlive On

# MaxKeepAliveRequests: The maximum number of requests to allow
# during a persistent connection. Set to 0 to allow an unlimited amount.
# We recommend you leave this number high, for maximum performance.
#
MaxKeepAliveRequests 100

# KeepAliveTimeout: Number of seconds to wait for the next request from the
# same client on the same connection.
#
KeepAliveTimeout 15

# Apache on Win32 always creates one child process to handle requests. If
```

```
it
# dies, another child process is created automatically. Within the child
# process multiple threads handle incoming requests. The next two
# directives control the behaviour of the threads and processes.
#

# MaxRequestsPerChild: the number of requests each child process is
# allowed to process before the child dies. The child will exit so
# as to avoid problems after prolonged use when Apache (and maybe the
# libraries it uses) leak memory or other resources. On most systems, this
# isn't really needed, but a few (such as Solaris) do have notable leaks
# in the libraries. For Win32, set this value to zero (unlimited)
# unless advised otherwise.
#
MaxRequestsPerChild 0

# Number of concurrent threads (i.e., requests) the server will allow.
# Set this value according to the responsiveness of the server (more
# requests active at once means they're all handled more slowly) and
# the amount of system resources you'll allow the server to consume.
#
ThreadsPerChild 50

# Dynamic Shared Object (DSO) Support
#
#LoadModule anon_auth_module modules/ApacheModuleAuthAnon.dll
#LoadModule cern_meta_module modules/ApacheModuleCERNMeta.dll
#LoadModule digest_module modules/ApacheModuleDigest.dll
#LoadModule expires_module modules/ApacheModuleExpires.dll
#LoadModule headers_module modules/ApacheModuleHeaders.dll
# Load the proxy server
LoadModule proxy_module modules/ApacheModuleProxy.dll
#LoadModule rewrite_module modules/ApacheModuleRewrite.dll
#LoadModule speling_module modules/ApacheModuleSpeling.dll
#LoadModule status_module modules/ApacheModuleStatus.dll
#LoadModule usertrack_module modules/ApacheModuleUserTrack.dll

### Section 2: 'Main' server configuration
#
# The directives in this section set up the values used by the 'main'
# server, which responds to any requests that aren't handled by a
# <VirtualHost> definition.

# Port: The port to which the standalone server listens.
#
Port 80

# ServerAdmin: Your address, where problems with the server should be
# e-mailed.
#
ServerAdmin you@your.address

# ServerName allows you to set a host name which is sent back to clients
for
# your server if it's different than the one the program would get (i.e.,
use
# "www" instead of the host's real name).
#
ServerName 192.168.0.1

# DocumentRoot: The directory out of which you will serve your
```

```
# documents.
#
DocumentRoot "C:/Program Files/Apache Group/Apache/htdocs"

# Each directory to which Apache has access, can be configured with respect
# to which services and features are allowed and/or disabled in that
# directory (and its subdirectories).
#
# First, we configure the "default" to be a very restrictive set of
# permissions.
#
<Directory />
    Options FollowSymLinks
    AllowOverride None
</Directory>

# Note that from this point forward you must specifically allow
# particular features to be enabled.
#

# This should be changed to whatever you set DocumentRoot to.
#
<Directory "C:/Program Files/Apache Group/Apache/htdocs">

# This may also be "None", "All", or any combination of "Indexes",
# "Includes", "FollowSymLinks", "ExecCGI", or "MultiViews".
#
    Options Indexes FollowSymLinks

# This controls which options the .htaccess files in directories can
# override.
#
    AllowOverride None

# Controls who can get stuff from this server.
#
    Order allow,deny
    Allow from all
</Directory>

# UserDir: The name of the directory which is appended onto a user's home
# directory if a ~user request is received.
##
UserDir "C:/Program Files/Apache Group/Apache/users/"

# DirectoryIndex: Name of the file or files to use as a pre-written HTML
# directory index.
#
DirectoryIndex index.html

# AccessFileName: The name of the file to look for in each directory
# for access control information.
#
AccessFileName .htaccess

# The following lines prevent .htaccess files from being viewed by
# Web clients.
#
<Files .htaccess>
    Order allow,deny
    Deny from all
```

```
</Files>

# UseCanonicalName: (new for 1.3) With this setting turned on, whenever
# Apache needs to construct a self-referencing URL (a URL that refers back
# to the server the response is coming from) it will use ServerName and
# Port to form a "canonical" name. With this setting off, Apache will
# use the hostname:port that the client supplied, when possible. This
# also affects SERVER_NAME and SERVER_PORT in CGI scripts.
#
UseCanonicalName On

# TypesConfig describes where the mime.types file (or equivalent) is
# to be found.
#
TypesConfig conf/mime.types

# DefaultType is the default MIME type the server will use for a document
# if it cannot otherwise determine one, such as from filename extensions.
# If your server contains mostly text or HTML documents, "text/plain" is
# a good value. If most of your content is binary, such as applications
# or images, you may want to use "application/octet-stream" instead to
# keep browsers from trying to display binary files as though they are
# text.
#
DefaultType text/plain

# HostnameLookups: Log the names of clients or just their IP addresses
# e.g., www.apache.org (on) or 204.62.129.132 (off).
#
HostnameLookups Off

# ErrorLog: The location of the error log file.
#
ErrorLog logs/error.log

# LogLevel: Control the number of messages logged to the error.log.
#
LogLevel warn

# The following directives define some format nicknames for use with
# a CustomLog directive (see below).
#
LogFormat "%h %l %u %t \"%r\" %>s %b \"%{Referer}i\" \"%{User-Agent}i\""
combined
LogFormat "%h %l %u %t \"%r\" %>s %b" common
LogFormat "%{Referer}i -> %U" referer
LogFormat "%{User-agent}i" agent

# The location and format of the access logfile (Common Logfile Format).
#
CustomLog logs/access.log common

# Optionally add a line containing the server version and virtual host
# name to server-generated pages (error documents, FTP directory listings,
# mod_status and mod_info output etc., but not CGI generated documents).
# Set to "EMail" to also include a mailto: link to the ServerAdmin.
# Set to one of: On | Off | EMail
#
ServerSignature On

# Aliases: Add here as many aliases as you need (with no limit). The format
```

```
is
# Alias fakename realname
#
Alias /icons/ "C:/Program Files/Apache Group/Apache/icons/"

# ScriptAlias: This controls which directories contain server scripts.
#
ScriptAlias /cgi-bin/ "C:/Program Files/Apache Group/Apache/cgi-bin/"

<Directory "C:/Program Files/Apache Group/Apache/cgi-bin">
    AllowOverride None
    Options None
</Directory>

# Redirect allows you to tell clients about documents which used to exist
in
# your server's namespace, but do not anymore. This allows you to tell the
# clients where to look for the relocated document.
# Format: Redirect old-URI new-URL
#

# Directives controlling the display of server-generated directory
listings.
#

# FancyIndexing is whether you want fancy directory indexing or standard
#
IndexOptions FancyIndexing

# AddIcon* directives tell the server which icon to show for different
# files or filename extensions. These are only displayed for
# FancyIndexed directories.
#
AddIconByEncoding (CMP,/icons/compressed.gif) x-compress x-gzip

AddIconByType (TXT,/icons/text.gif) text/*
AddIconByType (IMG,/icons/image2.gif) image/*
AddIconByType (SND,/icons/sound2.gif) audio/*
AddIconByType (VID,/icons/movie.gif) video/*

AddIcon /icons/binary.gif .bin .exe
AddIcon /icons/binhex.gif .hqx
AddIcon /icons/tar.gif .tar
AddIcon /icons/world2.gif .wrl .wrl.gz .vrml .vrm .iv
AddIcon /icons/compressed.gif .Z .z .tgz .gz .zip
AddIcon /icons/a.gif .ps .ai .eps
AddIcon /icons/layout.gif .html .shtml .htm .pdf
AddIcon /icons/text.gif .txt
AddIcon /icons/c.gif .c
AddIcon /icons/p.gif .pl .py
AddIcon /icons/f.gif .for
AddIcon /icons/dvi.gif .dvi
AddIcon /icons/uuencoded.gif .uu
AddIcon /icons/script.gif .conf .sh .shar .csh .ksh .tcl
AddIcon /icons/tex.gif .tex
AddIcon /icons/bomb.gif core

AddIcon /icons/back.gif ..
AddIcon /icons/hand.right.gif README
AddIcon /icons/folder.gif ^^DIRECTORY^^
AddIcon /icons/blank.gif ^^BLANKICON^^
```

```
# DefaultIcon is which icon to show for files which do not have an icon
# explicitly set.
#
DefaultIcon /icons/unknown.gif

# ReadmeName is the name of the README file the server will look for by
# default, and append to directory listings.
#
# HeaderName is the name of a file which should be prepended to
# directory indexes.
#
# The server will first look for name.html and include it if found.
# If name.html doesn't exist, the server will then look for name.txt
# and include it as plaintext if found.
#
ReadmeName README
HeaderName HEADER

# IndexIgnore is a set of filenames which directory indexing should ignore
# and not include in the listing. Shell-style wildcarding is permitted.
#
IndexIgnore .??* *~ *# HEADER* README* RCS CVS *,v *,t

# AddEncoding allows you to have certain browsers (Mosaic/X 2.1+)
uncompress
# information on the fly. Note: Not all browsers support this.
# Despite the name similarity, the following Add* directives have nothing
# to do with the FancyIndexing customisation directives above.
#
AddEncoding x-compress Z
AddEncoding x-gzip gz

# AddLanguage allows you to specify the language of a document. You can
# then use content negotiation to give a browser a file in a language
# it can understand. Note that the suffix does not have to be the same
# as the language keyword --- those with documents in Polish (whose
# net-standard language code is pl) may wish to use "AddLanguage pl .po"
# to avoid the ambiguity with the common suffix for perl scripts.
#
AddLanguage en .en
AddLanguage fr .fr
AddLanguage de .de
AddLanguage da .da
AddLanguage el .el
AddLanguage it .it

# LanguagePriority allows you to give precedence to some languages
# in case of a tie during content negotiation.
# Just list the languages in decreasing order of preference.
#
LanguagePriority en fr de

# The following directives disable keepalives and HTTP header flushes.
# The first directive disables it for Netscape 2.x and browsers which
# spoof it. There are known problems with these.
# The second directive is for Microsoft Internet Explorer 4.0b2
# which has a broken HTTP/1.1 implementation and does not properly
# support keepalive when it is used on 301 or 302 (redirect) responses.
#
BrowserMatch "Mozilla/2" nokeepalive
```



```
BrowserMatch "MSIE 4\.0b2;" nokeepalive downgrade-1.0 force-response-1.0

# The following directive disables HTTP/1.1 responses to browsers which
# are in violation of the HTTP/1.0 spec by not being able to grok a
# basic 1.1 response.
#
BrowserMatch "RealPlayer 4\.0" force-response-1.0
BrowserMatch "Java/1\.0" force-response-1.0
BrowserMatch "JDK/1\.0" force-response-1.0

### Section 3: Virtual Hosts
# Listen: Allows you to bind Apache to specific IP addresses and/or
# ports, in addition to the default. See also the <VirtualHost>
# directive.
#
Listen 80
Listen 192.168.100.2:8080
<VirtualHost 192.168.100.2:8080>
    ServerName Proxy
    ProxyRequests On
    CacheSize 10240
    CacheRoot C:/ProxyCache
    HostnameLookups Off
</VirtualHost>
```