

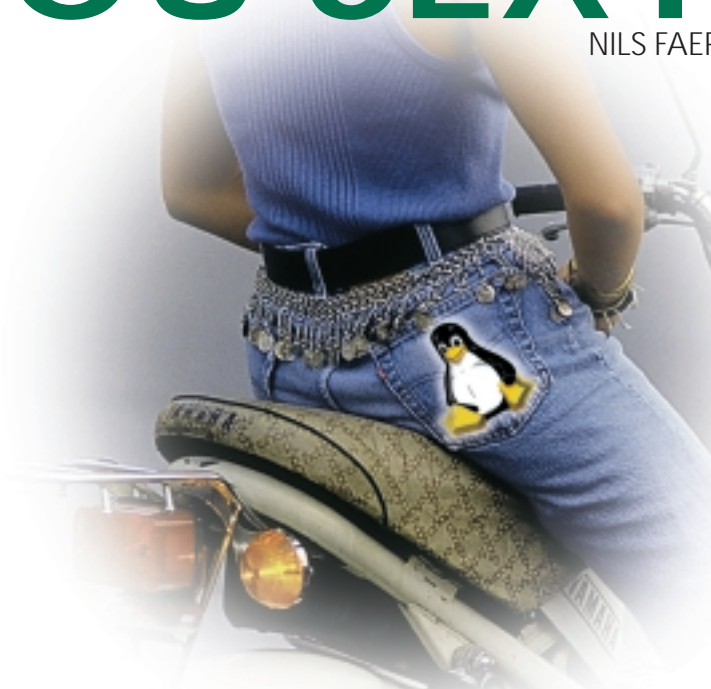
ON TEST

IPAQ

Compaq iPaq on test

YOU SEXY THING

NILS FAERBER



Handhelds are advancing. Although Compaq doesn't yet ship its new organiser flagship with Linux preinstalled, there are now two Linux distributions for the iPaq. Now no-one has to go without a proper shell while out and about.

I didn't pay much attention when the first rumours surrounding the iPaq started at the beginning of the year. There had already been a great many product announcements, which soon turned out to be design studies or prototypes and dashed all our hopes. The rumours surrounding the iPaq quietened down too.

Then suddenly the finished product was announced and there was an abundance of information, and at almost the same time, news of the Linux port developed by Compaq itself. The first concrete information became available: 206 MHz StrongARM CPU, 32 MByte RAM, 16 MByte flash, a colour TFT screen. What would it be, then? A netwinder for the rucksack? Observers may have thought it impossible to fit all that into a PDA. Then the first pictures on the Net. It's a PDA! And rather a good-looking one too. It holds IrDA, USB and RS232 interfaces, almost a connectivity wonder. With a compact flash and PCMCIA slot too. And even more gems in the form of stereo-audio with 16 bit 44 kHz and a headphone connection.

Even more pictures! It really does exist. But the pictures certainly conceal the true size. It must be large – how else can it accommodate everything? Then the shock – finally, the dimensions were found on the Net: 78mm wide, 130mm high and 16mm thin. The whole thing weighs less than 170g. After a virtually endless search we finally found two iPaqs available for testing but were unable to wait for them to be dispatched. We immediately drove to collect them. The price of nearly £400 inc. VAT was high, but we felt it was worth it.

Unpacking it

The iPaq comes with a serial docking station, power pack, spare pen, the inevitable Windows synchronisation software (Active Sync), a leather case and a dummy jacket. The iPaq's casing is made of metal-plated plastic, fits snugly into the hand and feels solid. At first glance, the built-in holder for the pen seems as if it has a small design error. The pen itself has an oval profile, but unfortunately it is not symmetrical! If you are not careful when you insert the pen into the holder and push it using only a little too much force, it is almost impossible to get it out again. The power pack can be connected to both the docking station and the iPaq itself. Very sensible, as users don't always need the station to recharge the iPaq.

When we first unpacked the iPaq it turned into a fiasco almost immediately, as neither of the two iPaqs were prepared to show the slightest sign of life. The trick was that the resourceful Compaq engineers had incorporated a switch to protect the built-in lithium polymer battery (900mAh). This can be used to completely cut off the power supply: particularly important if the iPaq is not used for a longer period, as you must *never* let a lithium polymer battery run low! When the iPaq is shipped from the factory this small switch on the lower edge of the iPaq is in the "off" position. Once switched on, the picture was immediately quite different.

With a resolution of 320x240 pixels, the iPaq's screen is really quite large in comparison with a Palm or Helio. The contrast is good and the

backlight ensures that the display is always readable. If the backlight is turned off, the transflexive display still provides enough contrast so that readability continues to be good where the lighting conditions are somewhat better. Under Windows CE 3.0 the brightness of the light is adjusted automatically via an in-built light sensor to suit the lighting conditions.

Jackets and Sleeves

Expansion packs for the iPaq are described as „Jackets“ or „Sleeves“, into which the iPaq can be inserted quite easily. The jackets hardly make the iPaq any bigger, just somewhat fatter depending on the type of jacket. For this purpose the iPaq has on its lower edge not only a socket for the combined RS232/USB and power pack plug but also a system plug where all sorts of interesting signals can be found. These include the compact flash and PCMCIA interface, an audio-line-out output and an input for an external battery pack.

Only the compact flash jacket is available at the present time. The PCMCIA jacket with a built-in battery pack to supply the PCMCIA cards is to follow very soon. Other jackets are already under discussion, including a game jacket with larger loudspeakers and special user elements that are especially suitable for games. There are practically no limits to the imagination here and there are sure to be several crazy developments. Compaq has published the specifications for the interface and for the iPaq as a whole. There will also be a development jacket for interested developers. This consists of an empty jacket with the special plug-in contact so that one's own design can be inserted fairly easily.

Unfortunately, the jackets are relatively expensive. The compact flash jacket will cost between £40 and £50, the PCMCIA jacket between £75 and £100. Let's hope that these prices will fall if sales are high.

But now to Linux!

As mentioned, the iPaq incorporates 16MB of flash memory. This is loaded with Windows CE 3.0 at the factory. Unfortunately, this is deleted by the installation of Linux. Although it is possible to read out and save the flash memory contents using the Windows CE boot loader, no-one is guaranteeing that it will ever be possible to get the saved code back into the flash. But quite honestly, who wants that?

This is also the most critical moment in the Linux installation process. The entire flash is reprogrammed and the boot loader too, which causes the hardware to run once it is switched on. If the data is written incorrectly during the installation process you will have a wonderful but expensive paperweight or a case for the service engineers. It is

not known whether and how Compaq provides compensation or carries out repairs if this happens. I have only ever heard of one case where this was necessary. In this case the party concerned lived two streets from the Compaq lab in the USA and was invited by the developers to simply drop by.

The iPaq's initial installation process is relatively simple. You should obtain the latest version of the Windows CE boot loader (currently *osloader-1.3.0.exe* from distribution V0.15) from *handhelds.org*. This is a program for Windows CE containing the same bootloader used to boot the system, only this one is booted not from the flash memory but from the Windows CE program. There are only three options available to get the *osloader* program on the iPaq. Straight away we are unable to implement one of these three:

- Load the file onto the iPaq from a Windows PC using Active-Sync. However, I do not have Windows.
- Write the file to a compact flash card and start it on the iPaq using compact flash jacket. If you do not have a CF jacket or cannot write to CF cards, only the third option remains.
- Establish a PPP direct connection between iPaq and the Linux computer and transfer the file from the Linux computer using Windows CE Internet Explorer. Not the simplest method, but it works.

Once the OS loader is safely on the iPaq, things become exciting. On the Linux computer boot a terminal program (e.g. *minicom*) and configure it for the interface to which the iPaq is connected. The following parameters are probably the most advisable: 115200 baud, 8 data bits, 1 stop bit, no handshake, neither RTS/CTS nor XON/XOFF. If the terminal program has reached this stage, you should boot the OS loader on the iPaq and select *Tools->Bootld->Run*. Shortly after, the iPaq's screen should be switched off and the boot loader message *boot>* should appear in the terminal program. Thus far nothing has happened and a restart would restart WindowsCE. However, the next step could be the killer and some preparation is required.

Installation of the boot loader

The boot loader, and all other components to be programmed into the flash, are transferred to the iPaq via the serial XModem protocol. The XModem implementation in the boot loader is still somewhat flaky and doesn't like it at all if there is a delay before the transfer starts.

The recommended procedure is as follows. First enter the boot loader command to start receiving. Then send the file from the Linux computer. There should be a period of no more than one to two seconds between the time the boot loader command is entered and the time the file is sent. However, the method described below works reliably. In the case of Minicom, quit it using the

option "Q" instead of "q" so that the current interface settings are not reset. If you are not using a Minicom, the following script can be used to initiate the procedure:

```
#!/bin/sh

if [ -z "$1" ]; then
    echo "Usage:"
    echo "  $0 <ttydev>"
    exit
fi

stty 115200 -echo -echok -echoe -echoctl -eczhoke -onlcr -inlcr <$1
```

The command to load the boot loader then has to be issued to the iPaq. A simple `echo` is sufficient:

```
echo "load bootldr" > <<><\\><\\><\\><\\><ttydev>
```

A second script is now used to send the file:

```
#!/bin/sh

if [ -z "$1" -o -z "$2" ]; then
    echo "Usage:"
    echo "  $0 <filename> <ttydev>"
    exit
fi

sx -b $1 > $2 < $2
cat $2
```

This must be started immediately after the command to receive the file! `bootldr-0000-2.9.5` is given as the file for the first `load bootldr` command. This is the boot loader written to the boot sector of the flash (from address 0). After the transfer is completed the display shows the boot loader messages, which should end with " verifying ... done." . After this the iPaq can be removed from the station and the reset button activated (a small hole on the lower edge, opposite the power pack socket).

Back in the station, the boot loader should generate another message. If in doubt, you should quit the script and restart the terminal program, pressing *Return* where necessary. Congratulations! The boot loader has now been started from the flash and the installation process can continue.

Status Quo

The next part of the installation procedure depends on what is to be installed on the iPaq. There are currently two alternatives available:

- Handhelds.org iPaq Linux Distribution, V0.12 to V0.15
- PocketLinux

The distributions named above differ in their installation methods. Even the installation method for the iPaq Linux V0.14 from Handhelds.org differs from that for V0.15. Fortunately, the installation method for the *Handhelds.org* version is well

documented for each release. Users will also find HTML files in the subdirectories of the individual versions.

Handhelds.org Linux

Handhelds.org is the main development site for the current iPaq-Linux. The site is intended to be a general platform for handheld Linux and offers the usual services such as WWW servers, mailing lists, FTP servers and CVS servers. It is all sponsored by Compaq, and so it is no wonder that the focus is currently on the iPaq.

The current development version of the iPaq distribution can also be found at the FTP server *ftp.handhelds.org* in the subdirectory */pub/linux/compaq/ipaq/*. The current version is V0.15. The distribution includes:

- Bootloader V2.9.5
- Linux kernel 2.4.0-test6-rmk5-np2-hh3, normal zImage
- Initial RAMdisk, cramfs Image
- root file system , cramfs Image
- usr file system, cramfs Image

Due to the ample flash memory on the iPaq, the *root* and *usr* file systems are very full and practically all the standard shell tools, such as *grep*, *cat*, *wc*, *ls*, etc., are included. This may sound somewhat strange, but those of you who have worked with downsized systems will know what a relief it is when everything works like a normal Linux system.

The *cramfs* images are written to the relevant flash areas during the installation process and mounted from there. This means there is no RAM disk copied to the memory. This saves a considerable amount of RAM, but has the disadvantage that the file system is not writeable. If it is to be changed, a new image has to be produced and programmed into the flash: therefore it is practically infeasible while the system is running.

In addition to the file systems with static data, a dynamic RAM disk is also set up. This RAM disk is dynamic in two senses. First, data can be stored here during run time which is no longer available, however, after a reset or other restart. Second, this is the new RAM-FS, which, in contrast to normal RAM disks of a fixed size, dynamically takes the memory required from the main memory and gives it back to the main memory too. This provides some scope for experimenting.

After the file system images have been installed using the bootloader and a reset has been activated, the Handhelds.org Linux immediately starts in a graphical mode, the LED flashes green and the user is requested to calibrate the pen on the touchpad. Once this is done, believe or not, an X11 opens!

Yes, an X server runs on the iPaq (see Figure 1). The X server currently runs in Landscape mode (i.e. not properly) but work is being done on this. Jim Gettys, one of the fathers of X11 and now an employee at Compaq made a substantial



contribution to the X11 version used. The X server itself is an extremely downsized version with a file size of around 600 Kbytes and approximately 1.2 Mbytes of memory for the run time.

The picture shows not only some of the standard X11 applications such as `xterm`, `oclock`, `xeyes` and `xload` but also `xscribble`, a handwriting recognition program for X11, which could be described as a mixture of Jot (used in Windows CE) and Graffiti (which comes with PalmOS). With some good will, this functions quite well and sends the recognised writing to the X11 program having the input focus. TWM is currently being used as the window manager. More complex applications such as the MP3 player GQmpeg have also been ported and are contained in the distribution, which leads us directly to the next topic.

Available drivers

Kernel development is mainly under way at Compaq and so the most up-to-date drivers can be found in the distribution from Handhelds.org. Quite obviously, the frame buffer is also supported, as the X server used relies on it. The touch-screen functions and serves as a mouse substitute under X.

GQmpeg has been ported for a good reason, as audio device support is provided too. The IrDA interface is recognised by the kernel and Fast IrDA (FIR - 4MBit/sec.) should function. But unfortunately, the current version lacks the IrDA protocol driver.

The compact flash and PCMCIA jacket can be used, making the data exchange considerably easier. It wasn't possible to test the USB driver due to the lack of a USB station, but it is also contained in the distribution. When connected to a Linux host computer it will then be possible to use the USB connection as a network connection, and therefore to use TCP/IP as normal.

Things that don't yet work

Power management is among the things that don't yet work. This means that the only way to put the

iPaq in energy-saving mode is to switch it off.

However, work is already under way on various options. One of these is known as a clock scaling expansion. This reduces or increases the CPU speed depending on the workload and thus saves a considerable amount of energy.

The backlight and the display itself are already switched on and off by the X11 and console screen saver. What is still lacking is a way of putting the computer to sleep properly, i.e. putting the CPU and the DRM in standby mode and switching off all the peripherals. This would then be the ultimate low energy mode. It isn't possible to consume much less than this.

However, this gives rise to a problem, as the iPaq doesn't have a real-time clock and the system time simply stands still in this kind of mode. It isn't easy to wake up the CPU either, as all the laboriously adjusted system settings, e.g. for the DRAM, have to be recalculated and initiated. The iPaq currently runs for about six to nine hours with a fully loaded battery and without any excessive demands on the system.

Apart from the lighting conditions sensor, all the hardware drivers are available and functioning (in the case of the audio driver, only from V0.16 onwards).

PocketLinux

Sponsored by Transvirtual Inc., PocketLinux is said to be a completely adequate Linux PDA desktop system using Java. Based on a customised Kaffee version, the frame buffer is also used directly in this instance. Its own GUI toolkit takes care of the graphical elements and display. For text input the developers have implemented their own handwriting recognition system similar to `xscribble` and a virtual keyboard in Java. The sparkling announcements and the screenshots shown on the website are promising, but a test is more sobering. The screenshots feign a completeness that doesn't exist in reality.

Almost nothing works, with the exception of the application manager and the notepad (at least

[left]
Fig 2: Handhelds.org-Linux with GQmpeg MP3 Player

[right]
Fig 1: Handhelds.org Linux, X11

not in our test). Performance also leaves a lot to be desired. The iPaq is unbelievably fast under X11 with the Handhelds.org Linux, but delays and glitches in the graphical interface occur under PocketLinux. The announcement that PocketLinux will be offered in the same form for the less powerful VTech Helio too is not promising. The ideas behind PocketLinux are certainly good, but it doesn't seem possible at the present time to produce a complete graphical application suite for PDAs in Java.

Nevertheless, it is worth a try. There's a downloadable demo for anyone wishing to try it on their iPaq. Unfortunately, there are no installation instructions, so here are a few quick tips:

- Only the two files *ipaq-image-linuxworld.video.zimage* and *ipaq-image-linuxworld.video.gz* are required for the demo.
- In contrast to the current Handhelds.org Linux version, these two files have to be programmed into the flash from the bootloader using **load kernel** and **load ramdisk**.
- The command line for the Linux kernel should be **linuxargs=„initrd root=/dev/ram ramdisk_size=16384“**.
- **boot** then starts the demo.

In-house developments

Compaq has also thought about its own in-house development. A complete ARM cross-development package is available from a second research project known as *Skiff*. The package contains all the programs required to generate the kernel and the user mode applications under x86er-Linux. This saves a considerable amount of work and fiddling about, and functions as soon as it is installed. The current kernel source and a few more source and binary packages are also available on the Handhelds.org FTP server. Although, due to the currently rapid rate of development, some of the documentation on the Handhelds.org WWW server is out of date, it is still a valuable source of information. Those of you with experience of system development shouldn't find it difficult to work on your own projects using the tools and documentation.

Compaq has another gem for larger development projects. *Skiff*, mentioned above, is a StrongARM-based project that seems to be focussing in on small servers. A few of these prototypes are already available in the Compaq labs and are freely accessible over the Internet. Five of these machines can be found at the addresses *skiffcluster[1-5].handhelds.org* and can be accessed via the account *guest* without a password using *telnet*, *ftp* and *rcp*. As hard disks are connected to these devices, larger projects can be directly compiled "native" without going via a cross-development environment.



Fig. 3: PocketLinux Desktop

Outlook

It seems as if the whole world is about to turn to embedded Linux. New desktops and new embedded toolkits are being announced everywhere. Trolltech has announced an embedded Qt which runs on the raw frame buffer without X11. In the GTK arena there are more and more rumours that this cannot simply be left and so there are plans to do something. However, tangible results occur rarely if at all. So let's stick to the facts.

Apart from the Agenda VR3 from Agenda Computing, a fully adequate Linux PDA doesn't exist at the present time. All the currently available models have a problem somewhere, usually in their power management.

The future of graphical interfaces for Linux PDAs is also completely unclear. For smaller devices X11 represents overkill, for the larger ones like the iPaq it seems feasible. The only question concerns the sense in having X11 on a PDA. The highly regarded network transparency can hardly be the reason, as when is a PDA on the Net? This leaves the portability of existing applications. But even this is not without its problems, as a resolution of just 320x240 pixels is today insufficient for most X11 programs. The question is really whether the window paradigm is practical for a PDA.

These are exciting times. Every day there is something new to discover in this area and I am sure there will be something for everyone. ■

Info

Handhelds.org homepage: <http://www.handhelds.org/>

Handhelds.org iPaq Linux FTP: <ftp://ftp.handhelds.org/pub/linux/compaq/ipaq/>

PocketLinux: <http://www.pocketlinux.org/>

PocketLinux demo: <ftp://ftp.pocketlinux.org/dists/bignoodle/main/flash-images-ipaq/>

ARM crossdevelopment package:

<ftp://ftp.handhelds.org/pub/linux/arm/toolchain/arm-linux-toolchain-post-2.2.13.tar.gz>

Agenda Computing Inc: <http://www.agendacomputing.com/>

vCard and vCal specifications: <http://www.imc.org/pdi/>