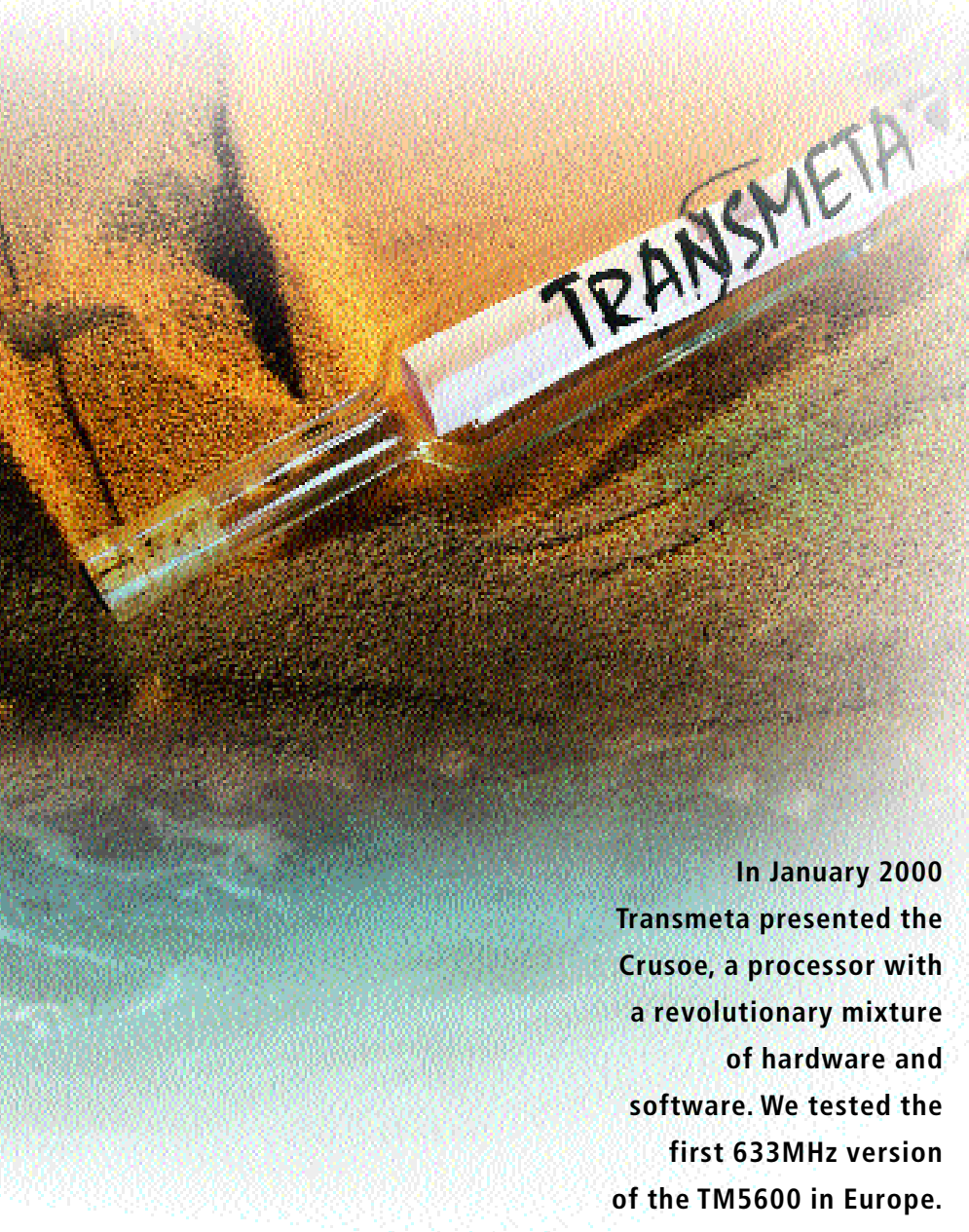
Transmeta Crusoe TM5600 in detail

MESSAGE IN A BOTTLE FROM TRANSMETA

MIRKO DÖLLE



In January 2000 Transmeta presented the Crusoe, a processor with a revolutionary mixture of hardware and software. We tested the first 633MHz version of the TM5600 in Europe.

The Crusoe TM5600 (with 633 MHz) has 128KB first-level cache, 512KB second-level cache and can split off a variable translation cache from the main memory of the computer. For the test we had exclusive use of the Fujitsu-Siemens Lifebook P with the TM5600. Unlike the usual Intel-compatible CPUs, the Crusoe is trimmed for minimum consumption instead of maximum performance.

Internal

The Crusoe contains noticeably fewer functional units than other x86 processors. Like the Mobile Pentium III it has two integers, one floating point, one memory and one unit step. ISSE and MMX units only come with Intel.

Today's x86 processors use out of order execution. The x86 command sequence specified by the program is first broken down by the decoder and translation unit into RISC-type micro-ops and distributed by the dispatch unit over the functional units. The sequence is determined by the available CPU resources, not by the program. The dispatch unit tries to use the CPU to full capacity. The results then have to be re-sorted by the in order retire unit. The aforementioned units are mostly realised by hardware and, with only a few exceptions, by software (jump prediction, optimisation, re-sorting).

Transmeta has the cut back heavily on the functionality of the control units or done away with them altogether and so manages with considerably fewer transistors.

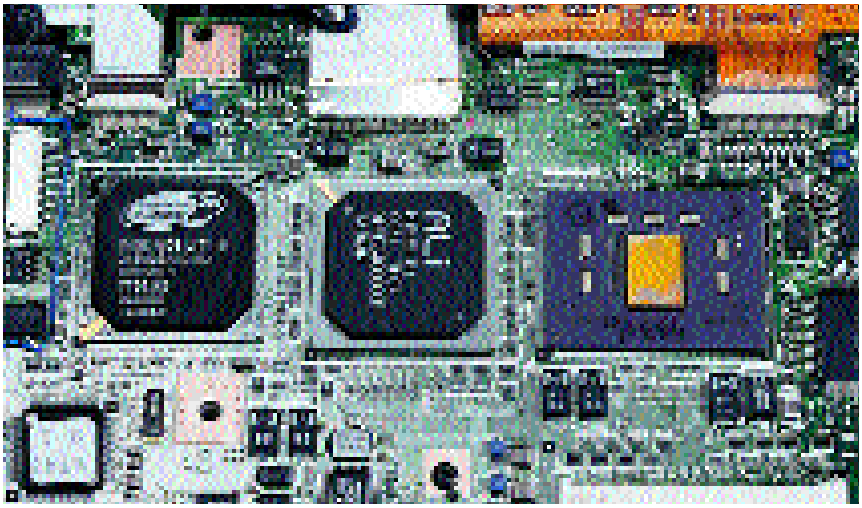
The Crusoe processor itself is not x86-compatible, but is a VLIW kernel with 64 or 128 bit commands. The decoder and dispatch unit responsible for the division of tasks is just a simple bit-distributor, which splits up the arriving command and writes it in parallel in the function units. There is no optimisation or re-sorting.

Software/ hardware mix

To run x86 programs on the Crusoe, there has to be a translation into the VLIW command set of the Crusoe. This is done by the code-morphing software, which Linus Torvalds was heavily involved in developing. This is loaded from the flash, which can be updated, into one part of the translation cache. In addition to translation, the software is responsible for the optimisation of the code up to the out of order execution, packs the result in bite-size chunks into VLI words and saves it in the translation cache.

The concept is similar to the FX32 expansion of Digital for Windows NT and Linux, which allows the execution of x86 programs on Alpha CPUs and saves the translation result created during the run time in a shadow file on the hard drive.

It takes a lot longer to translate the commands with the code morphing software than in the Decoder-Unit of the Pentium III. But unlike an almost purely hardware solution, considerably larger algorithms can be used. If the same command block comes up again for execution, the VLIW commands are supplied straight from the translation cache, without being retranslated.



The Crusoe TM5600 can be seen on the right with the south bridge and ATI graphics chips to the left

One for all

The encapsulation of the entire hardware by code morphing software opens up some completely new possibilities. So the VLIW kernel of the processor

Midori Linux

The Transmeta Crusoe is suitable as an extremely energy-economical processor especially for mobile PCs. Its main application is in the domain of notebooks, which need a high-performance x86-compatible CPU using as little energy as possible. What matters is that the operating system exploits the energy-saving abilities of the hardware.

Linux doesn't offer stable support for ACPI power management yet. And Linux systems are comparatively large – with a graphical user interface and browser they come to over 128MB.

Lean and mean

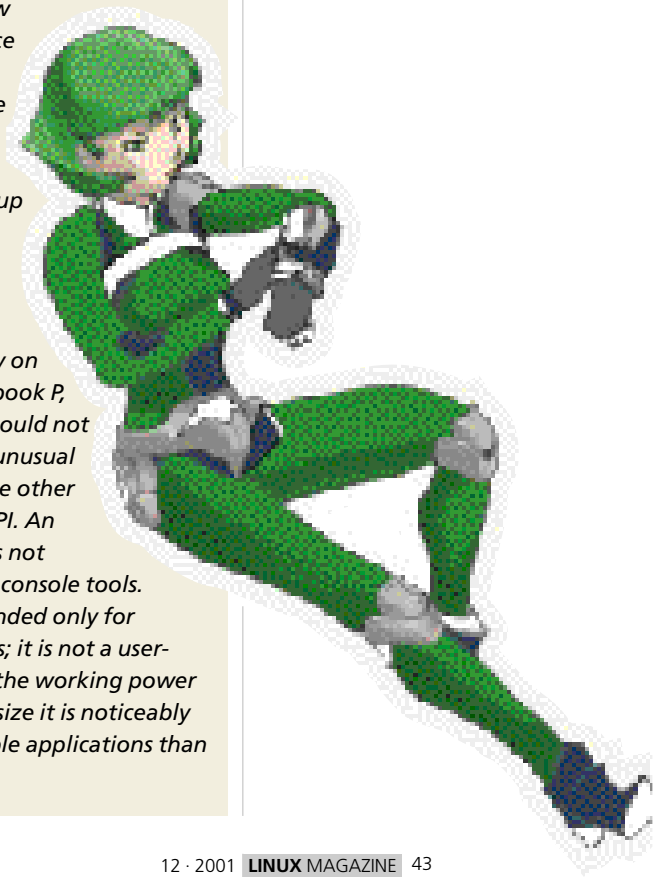
Transmeta has taken this problem on board and is presenting Midori Linux, which has optimal slimness and support for power management. Transmeta does not supply any complete binary packages, so the distribution in the version to which we had access (version 1.0.0-beta2), consists of a tar archive with Web-based configuration front end.

The Midori program packages are tarballs equipped with additional information with the ending mlz. After configuration the whole system is compiled using Cross-Compiler and then written as a hard disk image including partitioning onto a block device. Red Hat 6.2 is suitable for the compilation, while the help scripts failed on more recent Red Hat and SuSE releases.

You should allow a few hours and sufficient space on the hard disk for the first compilation because by the time you finish, sources, objects and binary packets will take up a good 1.6GB.

Midori in practice

We were unable to get Midori to run completely on the Fujitsu-Siemens Lifebook P, as XFree86 4.0.1 simply could not come to terms with the unusual display. The kernel on the other hand ran stably with ACPI. An application test was thus not possible, as there are no console tools. Midori is at present intended only for developers of mobile PCs; it is not a user-distribution. But due to the working power management and small size it is noticeably more suitable for portable applications than standard systems.



can be changed at will at any time, as happened with TM3200 and TM5400. Bugfixes or fundamental function changes are no problem. The x86 upwards-compatibility is retained, only the code morphing software has to be adapted.

Emulation of other CPU architectures is also possible, so there is a Java version of the code-morphing software. This is interesting for the development of new processors. It is possible to test the command set or develop software on very powerful, Crusoe-based development systems long before the first processor prototype.

So Transmeta has built a Crusoe with Clawhammer emulation for AMD, which is already in use. And the emulation of completely different architectures such as Power-PC or RISC is also possible, although their performance is limited by the VLIW hardware.

Transmeta has achieved additional energy savings with the Longrun power management. So the code morphing software dynamically adjusts the kernel voltage and the clock frequency can be reduced smoothly to 300MHz. This makes the Crusoe markedly different from Intel's Speed Step, which has only three stages.

By integrating the north bridge into the CPU the Crusoe TM5600 can separate off part of the main memory as translation cache and saves space on the PCB.

High integration

An additional advantage is that of the integration of the north bridge into the Crusoe, which is also trimmed for minimal power consumption. In all the Crusoe consumes, at a kernel voltage of 1.4V, a maximum of 2.9W including north bridge, a Mobile Pentium III comes in at a minimum of 5W plus 2 to 3W for the north bridge.

At the same time, the Crusoe – with the same structural size (18 millimetres) – is about a quarter smaller than Intel's Mobile Pentium III. As more chips fit onto one wafer, production gets cheaper. One other plus point is the space saved, so now essentially only three chips are now needed for a complete PC. ■

Fujitsu-Siemens Lifebook P with Crusoe TM5600

READY FOR THE ISLAND

MIRKO DÖLLE

The Transmeta Crusoe boosts the Fujitsu-Siemens Lifebook P to a phenomenal battery life of well over six hours. Linux Magazine has tested the new sub-notebook, which comes out in October.

The Lifebook P stands out because of its unusual hardware. The Transmeta Crusoe TM5600 has 633MHz and just a 10.1-inch display with 1280x600 pixels at 140 dpi – which is more than many inkjet printers can get onto paper. The pre-series model tested will be available in this format from October in all major electronics stores, but the price has not yet been fixed.

Of the 128MB RAM, 16MB is set aside for the translation cache of the Crusoe, and an expansion with standard SO-DIMMs is not possible. On the 15GB hard drive, it is planned to pre-install Windows Me, but delivery with Linux is currently floundering due to the lack of support for the modem and the control buttons for the DVD player built in below the display.

Run-time giant with multimedia

The Lifebook P is intended as a mini-multimedia machine, combining MP3, CD and DVD player in one and also offering the functionality of a standard PC. With a battery life of six hours, sixteen minutes and sixteen seconds, even on long holiday trips it is more than equipped to keep the peace among your offspring in the back seat with the latest Disney film.

The difference between the Lifebook P and the Fujitsu-Siemens Loox T is the 100MHz faster CPU.

The large battery tested here, which is only available as an extra, stores 39-watt hours of energy. With the little 19 Wh battery there is still over three hours run time. The design is somewhat unusual, but the silver surface does look finer and more robust.

Problems adapting

The Linux installation of Red Hat 7.1 and SuSE 7.1 and 7.2 is not unproblematic. With the X11 installation the standard modes refuse to work, so some manual labour is necessary. The Trident driver for the sound card did not work – a patched Alsa package is necessary to make it go.

At a weight of just 1.8kg and a battery capacity of over six hours, the Fujitsu-Siemens Lifebook P is a faithful companion. Never before has a notebook in the Pentium class been so frugal in terms of energy without major compromises in performance. The purely passively cooled CPU also makes the device of particular interest to those of you plagued by noise. The display with the extreme high dot density does, however, require good eyesight – or a good optician. ■

Fujitsu-Siemens Lifebook P	
Category	**Subnotebook**
Processor	Transmeta Crusoe TM5600
Memory [MB], (slot/free)	128 (1/0)
Hard disk [GB]	15
DVD-ROM	8x/internal
Drives open sideways	yes
Ports: PS/2 / serial / parallel / line	- / - / - / +
USB / Irda / TV	+ / - / +
Docking Port / ext. drives	- / -
Display: Type / Size [inch]	TFT / 10,1
Angle of installation [degrees]	180
Colour/ brightness ratio even	no
Keyboard: key lift / pressure point	good / detectable
Offset cursor block	no
Cursor functions without function key	no
Loudspeaker covered when writing	no
Mouse: Type / buttons	Trackpoint / 3
Battery: Type / Voltage [V] / Capacity [mAh]	Li-Io / 10.8 / 3600 (1800)
Battery life [h:min]	6:16 (3:03)
Pre-installed operating system	Windows Me
Graphics card	ATI 3D Rage Mobility P/M
Memory [MByte]	4
Modem chip (addressable)	Nitsuko Type 0002
Sound chip (addressable)	Acer Type 5451 (+)
Cardbus chipset	TI PCI 1410
Cardbus slots	1x Type II
TV output / connection	SVGA
Power off / sleep usable	+ / +
Usable on text console / under X11	+ / -
Width / Depth / Height [cm] (Weight [kg])	26.5 / 18.3 / 3.5 (1.8)
Noise level [db(A)]:	below measurement limit
Temperature [°C]: underside / keyboard	43 / 36
Temperature [°C]: card slot	44
Market launch	October 2001