NEC VR4122 Wrestles StrongArm

Mobile Processor for Windows CE Beats SA-1 But Can't Reach SA-2

by Tom R. Halfhill

It took four years and two leaps in IC process technology, but NEC Electronics has finally announced a mobile embedded processor that appears to surpass the StrongArm's famed combination of performance and power consumption. NEC's new VR4122, scheduled for production in 2Q00, barely edges out StrongArm's MIPS/watt ratio, though not quite its stated performance.

What's amazing about this contest is that Intel still manufactures the 32-bit StrongArm on a 0.35-micron, three-layer-metal process acquired from Digital, while NEC is building the 64-bit VR4122 on a sleek new 0.18-micron process (NEC's four-layer-metal UC3). That StrongArm is still in the race at all is a testament to Digital's circuit-design prowess, circa 1995.

NEC can't rest for long. Shortly after the VR4122 enters the market in 2Q00, we expect Intel to begin mass-producing the second-generation StrongArm (see MPR 5/10/99, p. 1), which will hit an incredible 600 MHz while consuming only 450 mW. As Table 1 shows, the SA-2's performance and MIPS/watt ratio will easily manhandle the VR4122—and all other mobile embedded processors announced to date.

Until Intel puts a price on the SA-2, however, NEC's chip could still be a better buy for cost-conscious customers who are designing palmtops for Windows CE. Although the VR4122 isn't pin-compatible with other VR41xx-series chips, it's a logical upgrade for companies such as Casio, IBM, Vadem, and Sharp that already use the VR4121 (see MPR 10/26/98, p. 20) and VR4111 (see MPR 10/6/97, p. 13).

Bigger Caches, PCI Bus

The VR4122 improves on the VR4121 in several ways. By moving to 0.18 micron, NEC was able to boost the maximum clock frequency to 180 MHz while reducing typical power consumption to only 270 mW at 1.8 V. (NEC will also offer a 150-MHz version of the VR4122 with an extended temperature range for industrial applications.) This nudges the chip's performance to 216 MIPS, which is only slightly higher than

the VR4121's 210 MIPS, but it cuts power by 23%. This yields a 33% better MIPS/watt ratio—and a 33% higher price.

NEC also doubled the size of the primary caches, which are now 32K for instructions and 16K for data. The larger caches and 64-bit core should allow the VR4122 to run real-world software better than the feeble Dhrystone 2.1 benchmark implies.

Another significant addition to the VR4122 is an integrated PCI controller. In part, it makes up for the absence of the LCD controller found on some other mobile embedded processors, such as Motorola's DragonBall. NEC says PCI gives customers more flexibility, because they can attach any graphics controller they want. But an external graphics controller requires more power than an integrated solution, because of the hefty I/O demands of the PCI bus.

NEC also announced a new VR4122 companion chip, the VRC4173, which integrates a two-channel USB host controller, a two-channel PC Card controller, two PS/2 interfaces, an AC97 audio interface, a keyboard controller, A/D and D/A converters, and 21 GPIO ports. Like the VR4122, it will begin sampling in 1Q00 and enter production in 2Q00. It costs $13 in 10,000-unit quantities.

The VR4122 is a worthwhile upgrade from the VR4121 and heralds even faster chips to come as NEC ramps up 0.18-micron production, but it faces tough competition when Intel unlimbers the new StrongArm. By 2001, Windows CE palmtops should be a lot more powerful. Ⓜ

Feature	VR4122 NEC	VR4121 NEC	VR4111 NEC	SA-1110 Intel	SA-2 Intel	SH7751 Hitachi
Architecture	MIPS	MIPS	MIPS	ARM	ARM	SuperH
CPU Core	VR4120A	VR4120	VR4110	SA-1	SA-2	SH-4
Core Width	64b	64b	64b	32b	32b	32b
I/O Bus Width	32b	32b	32b	32b	N/A	32b
Core Voltage	1.8 V	2.5 V	2.5 V	1.75 V	1.3 V	1.8 V
I/O Voltage	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V	3.3 V
Max Freq	180 MHz	168 MHz	70 MHz	206 MHz	600 MHz	167 MHz
Dhrystone 2.1	216 MIPS	210 MIPS	85 MIPS	230 MIPS	>700 MIPS	300 MIPS
PCI Interface?	Yes	No	No	No	N/A	Yes
SDRAM?	Yes	Yes	No	Yes	N/A	Yes
Compact Code	MIPS-16	MIPS-16	MIPS-16	No	Thumb	SuperH 16b
L1 Cache (I/D)	32K/16K	16K/8K	16K/8K	16K/8K	32K/32K	8K/16K
Power (typical)	270 mW	350 mW	185 mW	400 mW	450 mW	400 mW
IC Process	0.18μ	0.25μ	0.25μ	0.35μ	0.18μ	0.18μ
Price (10K)	$33	$25	N/A	$27	N/A	$39
MIPS/Watt	800	600	459	575	>1500	750
Availability	2Q00	Now	Now	1Q00	2H00	3Q00

Table 1. NEC's new VR4122 compares favorably with Hitachi's SH7751 and Intel's StrongArm SA-1110 in terms of performance and power consumption. But it's not as highly integrated as the SA-1110 and falls well short of Intel's performance claims for the second-generation (SA-2) StrongArm. N/A = information not available. (Source: vendors.)