

A RISC Workstation from Acorn

Dick Pountain

Acorn's R260 workstation boasts plenty of power

When Acorn launched its 32-bit ARM (Acorn RISC Machine) processor back in 1986, it was apparent that designers had more in mind for the chip than just powering the BBC personal computer, the Acorn Archimedes. The ARM and its memory controller (MEMC) chip were designed from the start to support a virtual memory environment such as Unix and were therefore suitable engines for a full-scale workstation.

Earlier this year, Acorn launched the R140, the first Unix workstation to be powered by the ARM chip set. The R140 is really a converted Acorn Archimedes 440 running Acorn's RISCiX version of MIT's X Window System. However, the Acorn Archimedes design has a built-in 4-megabyte maximum memory limitation (which was imposed by the design of the MEMC chip), and 4 MB is a little cramped for running modern Unix software. A MEMC 2 chip, which supports 16 MB of memory, is in the final stages of development, but it is not here yet. So Acorn has come up with a different approach.

Enter the R260 Workstation, which gets around this memory problem by the simple expedient of stringing together 4 MEMC chips to support up to 16 MB of RAM. The R260 also sports the new superfast ARM 3 processor with its on-chip cache, which results in a very high performance X workstation for less than £4000.

Multiple CPU Slots

Externally, the R260 looks just like an Acorn Archimedes, until you start to count the I/O connectors on its rear panel. But internally (see the figure), the R260 has a completely new motherboard that contains 4 MB of memory and all the video and I/O circuitry but no CPU. Instead, it has four proprietary expansion slots for processor cards, one of which is permanently occupied by the ARM 3 processor, mounted vertically on an expansion card. This will allow you to up-

grade easily to possible future ARM 4, 5, and 6 CPUs as they arrive.

On the machine I tested, two of the remaining three slots held 4-MB memory-expansion cards, providing a total of 12 MB (8 MB is standard for the R260). Each memory card is barely larger than a playing card, containing eight of the latest surface-mount 4-megabit DRAM chips and its own private MEMC controller chip. As extra cards are plugged in, their MEMCs form a cascade, under the master control of the fixed MEMC chip on the motherboard—an elegant work-around for the memory problem.

The ARM 3 processor is clocked at 30 MHz, but thanks to its 4K bytes of on-chip cache memory, the rest of the system does not need to run at such speed. The memory bus runs at a more modest 12 MHz, which permits the use of 80-nanosecond chips, and the I/O bus runs at a positively sedate 8 MHz for compatibility with Archimedes peripherals.

The ARM 3 cache is of a relatively simple design (compared to, say, Intel's latest efforts), caching both data and instructions in the same fast memory. The ARM runs at a full 30 MHz when reading from cache and slows down (thanks to its variable clock design) whenever it has to talk to off-chip memory or peripherals.

Acorn has promised a floating-point accelerator chip, custom designed to work with the ARM, in the early part of 1991. This chip will fit into a socket on the ARM 3 expansion card for maximum speed; signals will not need to pass over the external bus.

In addition to the processor bus slots, there are four I/O bus slots, as on the Archimedes, mounted horizontally on a bulwark that divides the case. Only one of these was filled, by a SCSI card for the 100-MB hard disk drive that comes standard with the R260.

The R260 has more I/O capacity than the Archimedes, for, in addition to the obligatory serial and parallel ports, both thick and thin Ethernet connectors are standard. There is even a 3.5-mm jack socket for stereo sound and a SCSI connector for daisy chaining extra SCSI peripherals, such as streaming tapes and optical disk drives.

Video output, as on the Archimedes, is driven by the third member of Acorn's RISC chip set, VIDC (for video controller). In addition to all the Archimedes video modes, the R260 supports three new VGA-compatible modes: 640 by 480 pixels with 16 colors; 640 by 480 pixels with 256 colors; and Super VGA 800 by 600 pixels with 16 colors. VIDC emulates these VGA modes in software, so no actual VGA chips are used.

The Super VGA mode will require a suitably high-resolution multiscan monitor. Two monitor outputs are provided, one a nine-pin D connector and the other a triple coaxial outlet for large CAD/CAM monitors.

The R260 is supplied with a 12-function-key keyboard and the conventional three-button mouse as used on the Archimedes.

RISCiX

Acorn's version of Unix, RISCiX, started life as a straight port of Berkeley BSD 4.2, graduated through BSD 4.3, but now has evolved into yet another proprietary brand of Unix. The kernel has many enhancements, including code sharing for C and X libraries and support for Unix System V features such as shared memory, semaphores, Network File System (NFS), and interprocess communication.

Acorn has submitted RISCiX for validation as X/Open- and POSIX-compliant, which should be reassuring to potential software vendors. The perpetual turmoil in the Unix world finds its reflection on the R260's hard disk, which carries numerous binary directories with names like /bin, /sbin, /5bin, and /xbn, all full of alternative tools to support different varieties and flavors of the operating system. RISCiX is a large system even by Unix standards, filling approximately 66 MB of the 100 MB available on the SCSI disk.

The R260 also has in ROM Acorn's own single-user, multitasking operating system, RISC OS (as used on the Archimedes). In fact, it is RISC OS rather than RISCiX that is responsible for initially booting the computer. You can reserve a partition on the hard disk for RISC OS software and use the R260 as a dual-operating-system computer. As normally delivered to customers, though, the R260 boots straight into RISCiX multi-

user mode; you never see RISC OS. To enter RISC OS, you must log out of Unix by typing `halt -RISCOS`.

RISC OS boots RISCiX by executing a RISC OS module called RISCiXFS, which then loads VNUiX, the Acorn Unix kernel, and removes all traces of RISC OS from memory.

Since the R260 is mainly intended to be a network workstation, you can also enter RISCiX in single or multiuser mode. Single-user mode is useful for system administrators because it allows them to perform housekeeping jobs off the network.

Once you have booted RISCiX, you will be invited to log on and enter a password in normal Unix fashion. Typing in the word `root` or a user account name places you in a standard Bourne shell, which fills the whole screen, and you have a plain Unix system. You can use a text file called `rc` in the `/etc` directory to tailor the system to your preferences at boot time; it is equivalent to the DOS

`AUTOEXEC.BAT`.

RISCiX can access the 3½-inch floppy disk drive of the R260, either as a 1.44-MB Unix file system (which must be mounted before use) or as a DOS format device of 720K bytes. To read and write DOS files, RISCiX uses a completely separate set of utilities, such as `msdosls` (to list the directory), `msdoscp` (to copy files from floppy disk), and `wrmsdos` (to write files to floppy disk).

The R260 cannot execute DOS programs under Unix, though it can under RISC OS using the PC Emulator. You can also compress and archive files across multiple floppy disks using the Unix `dsplit`, `compress`, and `tar` utilities, and Acorn employs the `tar` format to distribute software packages. An interactive program called `packageadmin` allows you to load such packages onto the hard disk without having to type all the runes that `tar` requires.

There are a number of network-specific features of RISCiX that I could not



THE FACTS

R260 Workstation

with 8 MB of memory and a 100-MB SCSI hard disk drive, £3995

R255 Diskless Workstation

with 4 MB of memory, £1995

Acorn Computers Ltd.
Cambridge Technopark
645 Newmarket Rd.
Cambridge CB5 8PD
UK
44-223-214411
Inquiry 1003.

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PRELIMINARY BYTE BENCHMARKS

BYTE's Unix benchmarks show that the Acorn R260 is just slightly faster than the Everex Step 386/33, overall. If, however, you disregard the floating-point math tests (since the R260 was not equipped with an FPU), the Acorn appears to be significantly faster (by about 20 percent) than the Everex.

	R260 time (seconds)	Everex time (seconds)	R260 performance index ¹
C Compiler	3.33	2.06	0.62
DC Arithmetic	0.33	0.63	1.91
Tower of Hanoi	0.63	0.56	0.89
System Loading ²	19.6	17.3	0.88
Floating Point	74.12	11.92	0.16
Dhrystone2 (Dhry./sec.)	23,333	13,847	1.69
Cumulative index (vs. 6.0 for Everex Step 386/33)			6.15

¹ Indexes show relative performance; for each, an Everex Step 386/33 running Xenix 2.3.1=1.

² Eight concurrent background processes. (For details on the benchmarks, see "The BYTE Unix Benchmarks," March BYTE.)

adequately test on my single machine. In particular, the Sun NFS lets you transparently mount and access directories on remote network stations and use them as if they were on your local disk. "Transparent" in this context means that you don't have to know the network address of the target files.

RISCiX also supports the Network Information Service, which makes system administration files transparently available across a network, and the Automounter, which even removes the need for a user to manually mount a remote file system. The Automounter consults a database of the remote machines that you are allowed to use and automatically mounts file systems from those machines when you access them with a `cd /net-<machinename>` command. This makes booting a much faster process, since remote mounting does not need to happen at boot time. A remote file system that is not accessed for 5 minutes gets automatically unmounted.

The R260 is shipped with C, Pascal, and FORTRAN-77 compilers as standard, TCP/IP network software, and Sun's Yellow Pages administration database package.

X Window Support

The R260 supports graphical operations by using X Window in its latest 11.4 version (see "The X Window System," January 1989 BYTE). If you enter `x` as the account name at the first log-on prompt, the system will start up the RISCiX XServer; a graphics screen is cleared, and a dialog box appears that asks you for an account name and password. The XServer was written in-house by Acorn and incorporates some new features that

have been, as is the custom, offered back to MIT for public use. You can also start the XServer by typing `xstart` at a shell prompt, or you can set the R260 to boot straight into X Window.

When you've logged on successfully, a colorful menu appears, with a highly fashionable bas-relief appearance like the one in Microsoft Windows 3.0. This menu invites you to choose either an MIT or a Motif session. MIT and Motif represent two alternative X managers (they are actually called `Twm` and `Mwm` in X jargon). X Window does not actually prescribe the appearance and interaction style of windows; that is left up to a client (i.e., application) program called the window manager. You can even change window managers, and hence the appearance of the system, while programs are running.

Motif is the new standard graphical user interface (GUI) being pushed by the Open Systems Foundation group of Unix vendors, which includes DEC and IBM. In Motif, all the windows have three-dimensional borders with scroll bars and buttons that close, iconize, zoom, or resize the window.

As with Microsoft Windows, Motif windows can be moved around simply by holding down the left mouse button anywhere in the window and dragging. When you press the Iconize button, a Motif window shrinks down to a small icon on the desktop, but the process that owns it keeps running. A double-click will reopen the window.

By contrast, MIT windows follow the original X style and are much plainer than Motif; they have thin line borders and fewer buttons. They can be moved only by selecting a menu option and can

be resized only by clicking on a box that turns the window into a "rubber band" grid that you stretch to size. The reason that Acorn included `Twm` (the MIT-style manager) is that it is the standard manager distributed with X Window 11.4 and the only one officially supported by MIT. Motif will be far more attractive to most users.

When you select, say, a Motif session, a permanent menu box called the Session Manager (one of Acorn's innovations) appears. This menu offers these options: Help, XClients, Errors, Save Session, or Logout (of X Window, not Unix itself). Saving your session means that all the windows and applications will be restored as you left them next time you run Motif. The Errors option opens a window that reports errors from log-on scripts or from XClient programs; it cannot trap errors in ordinary Unix applications.

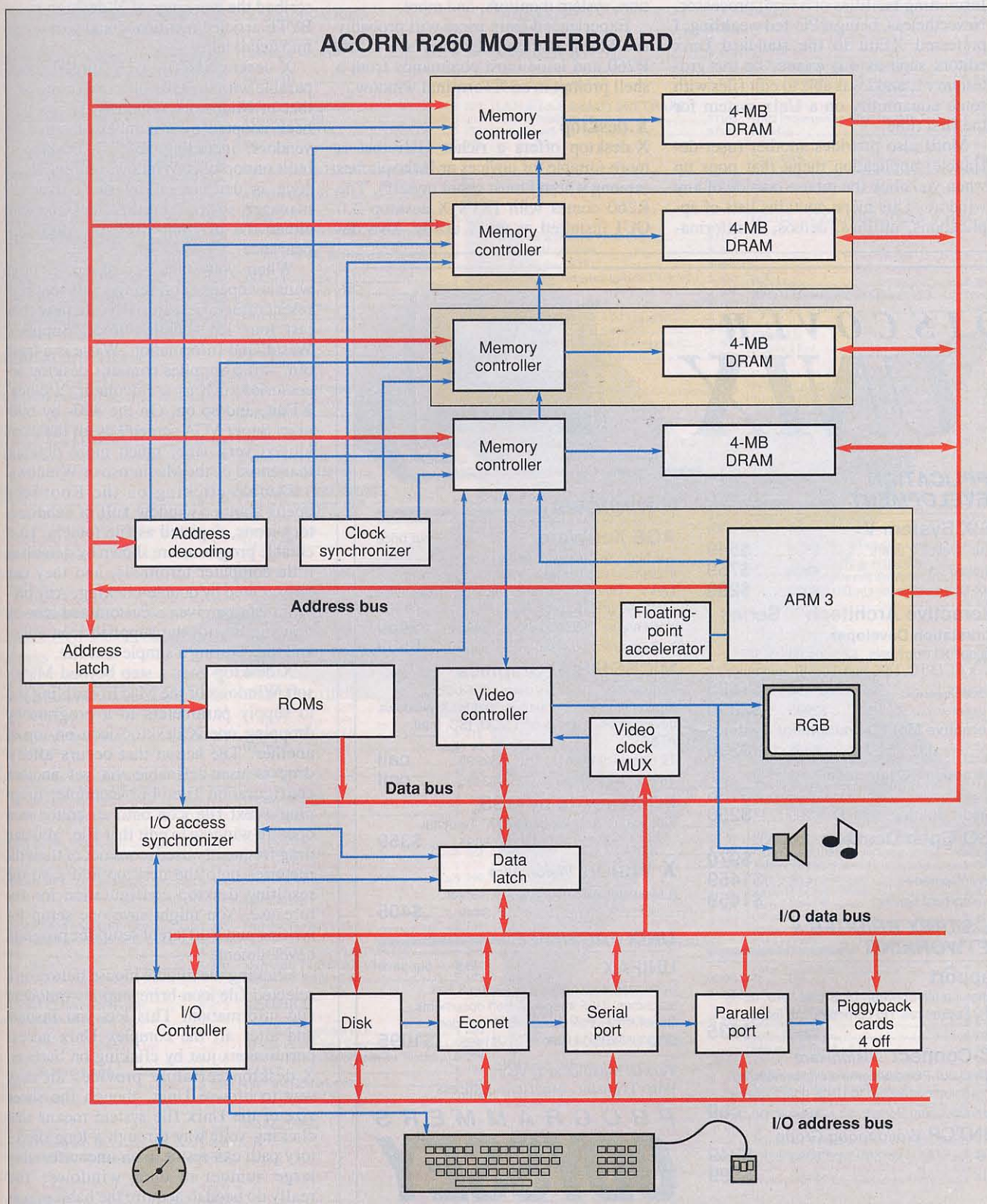
The XClients selector window contains buttons to start up various X utility programs, and you can alter its contents by editing a text file (this degree of user configurability runs all the way through X Window and can be rather overwhelming for newcomers). Three of the buttons select XTerminals 1, 2, and 3, which are windows that behave exactly like normal Unix shells. From these windows, you can start up any Unix program, not just XClients.

The R260 XServer also supports up to nine "virtual terminals," which means that it can behave like nine separate workstations in one box. This would allow you to switch between their different screens and even log in as a different user on each terminal. Virtual terminals, however, take a lot of memory, so my 12-MB system had only three configured; a full 16-MB system could have more. Virtual terminals can even be in different video modes, so you can load 16-color graphical images on one screen and 256-color images on another.

There is a small X utility called the XSwitcher that allows you to switch terminals with a single mouse-click. XTerminal windows are just software processes that all appear on the same virtual terminal screen, so you could have nine virtual terminals, each of which has three or more XTerminal windows on its screen—a whole network in one machine.

Another X utility program is a text editor called XEdit. XEdit is an interactive, window-based editor with only the simplest of capabilities, including mouse-driven cut and paste and search and replace. But it lacks the sophisticated

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Instead of a CPU, the Acorn R260's motherboard has four proprietary expansion slots. One of them is permanently occupied by the ARM 3 processor. Two of the remaining slots hold 4-MB expansion cards, each containing 4-megabit DRAM chips and its own MEMC chip. The diagram also shows video and I/O circuitry, including four I/O bus slots, serial and parallel ports, thick and thin Ethernet connectors, a socket for stereo sound, and a SCSI connector.

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20 to 25 MIPS

The R260 gives an immediate subjective impression of speed. Windows and menus open with a crispness that is often lacking on other X systems, and it makes interaction with the machine very satisfying. This speed comes in part from the fact that a 30-MHz ARM 3 is quite a formidable processor. It is capable of delivering 20 to 25 MIPS, although I suspect that much of the speed is due to XServer, which has been carefully tuned to exploit the ARM/VIDC architecture to the fullest extent.

This subjective feeling is confirmed by preliminary results of the BYTE Unix benchmark suite (see the table). The cumulative index of 6.15 suggests that the R260 is about as fast as the Everex Step 386/33 running SCO Xenix 2.3.1 (which has an index of 6.0). BYTE currently uses this machine as a baseline.

These results, of course, are subject to all the usual caveats about the significance of such a single index measure. However, if you inspect all the timings, you'll see that this combined index does less than justice to the R260: The Everex machine was fitted with an 80387 math

coprocessor, whereas the R260 did all its floating-point math in software (and consequently was six times slower on the floating-point benchmark). Assuming that Acorn's floating-point coprocessor will be at least as fast as the 80387, it looks likely that an FPU-equipped R260 could be about 20 percent faster than the baseline machine.

Prices

The Acorn R260 Workstation has a list price of £3995. This includes 8 MB of memory and a 100-MB SCSI hard disk drive. Purchasers are also required to buy one year of support, which costs £350. Additional memory is available at a price of £500 for 4 MB.

Acorn is also producing a diskless workstation version of the machine. This version, the R255, has a list price of £1999, plus a required one-year support contract of £162. The diskless version has only 4 MB of memory.

Needed: Applications

For less than the price of a similarly configured 386-based PC, the Acorn R260 provides a high-performance X worksta-

tion bundled with a very full Unix networking environment. Unix does not offer the same binary-code compatibility that is offered by the DOS world, however, and it remains to be seen how much support Acorn can attract from Unix application vendors.

The high-quality development tools and pending X/Open conformance bode well in this respect. I was supplied with samples of FORTRAN-based scientific applications that have already been ported from minicomputers to the R260, including the FECS finite-element-analysis package and the Acuity business graphics package. What Acorn needs to do now is to announce support from one of the major companies, such as Informix or Oracle.

One real advantage of the Acorn system is the existence of the diskless R255 workstation. This version enables X networks to be built inexpensively, and it should find much favor in colleges and universities. ■

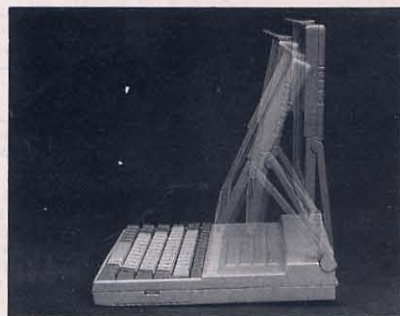
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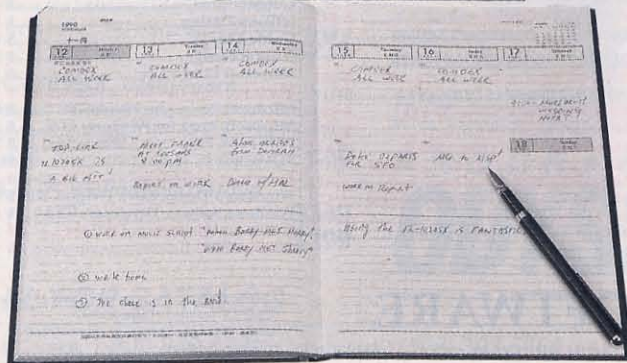
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