STATION EVALUATION

Mike Charnley-Fisher reports on life with the Atari Transputer Workstation

Atari's Transputer Workstation (ATW), currently known as the Abaq, is not yet in full production issue. I have been evaluating the ATW as part of a project at the engineering company where I work, and as a potential third party developer for the machine.

Throughout this discussion I will describe Issue 3 machines and then highlight the major differences which will appear in Issue 4 versions (the production model)

Figure 1 gives a schematic overview of the Abaq hardware and how this article examines it. Although more or less physically correct there are inconsistencies (for example Charity and video memory is on the main board but I shall deal with it mainly in connection with the Video Card).

The Mega ST2/4

The Motorola 68000-based Mega ST acts as the I/O processor. If you imagine having an Apple MacIntosh SE dedicated to simply looking after a floppy, keyboard, and mouse then this is what the Mega ST is treated as. My configuration is a Mega ST4, 20 Mb SH205 hard disk, and an Atari 300dpi SLM804 laser printer.

On the UK high street, with Desktop Publishing (DTP) thrown in this lot is available for about £2,800 (less than half the cost of an equivalent Apple system). Atari offers its own discount scheme for approved developers.

Issue 4 machines will have the main Mega ST board mounted internally. In order to keep the costs down Atari are taking advantage of the reduced chip counts (10 down to 2) resulting out of the Atari ST lapheld development. Since this board is only looking after certain I/O operations it will only have 0.5Mb of memory, although it will be expandable to allow the use of peripherals such as the Atari Laser printer. The Abaq will still be able to run ST based applications.

The Link Card

The link card currently sits on top of the main Mega ST board. It uses the internal DMA interface to the I/O processor and an Inmos link adaptor to the main Transputer. In addition to this high speed link this board also has a SCSI controller for interfacing to hard disks, tape drives etc. The transputer can access data through the SCSI at about 1.5Mb/s so it is a lot faster than the existing Atari hard disk controller.

On Issue 4 machines this Link I/O card will also have its chip count drastically reduced with most of it fitting in a single chip called Morpheus. Obviously this will fit inside the new Abaq case (which will possibly be a tower configuration).

Hard Disk Drives (SCSI)

Atari has still not decided on the final drive but the minimum configuration appears to be 40Mb storage with an average access of 30msec. The front runner (also to be used in Atari's forthcoming 68030 based Unix workstation) appears to be a removable media device.

Very shortly I hope to take delivery of a Maxtor XT-4170S drive. At just over the £1000 mark it gives 160 Mb storage with an average access time of 14msec. Towards Christmas I would hope to try on of Maxtor's recently announced erasable optical disk drives (1000 Mb, 30msec access, at under £4000) - Mainframe/mini vendors watch out!

Obviously any standard SCSI device may be fitted.

Transputer/Memory Card

The ATW comes shipped with a single Inmos T800 Transputer running at 17.5MHz and 4 Mb of user DRAM. Also on this board are the networking connections, the Charity chip, and expansion slot. The video side of Charity is discussed later, but its function here is to control memory refresh and other such mundane functions.

a) The Transputer

Just to repeat what others have already said, the Inmos T800 transputer is FAST compared with other processors. Table 1 gives an indication of this difference. (An IBM PC AT with maths co-processor uses the Intel 80286/80287, whilst the Mac II with extra coprocessor fitted uses the MC 68020/68881).

The floating point unit (FPU) performs so well when compared with traditional processors because it does not have to worry about off-chip communication (which accounts for a large proportion of the time taken with a conventional pair. Moreover it has been optimized to handle a reduced floating point instruction set, resulting in far faster operations, and it operates concurrently with the main CPU (which looks after address fetching).

The inbuilt networking facilities take the form of four bi-directional links. Each link operates concurrently with the main CPU and FPU and is able to communicate at a bidirectional speed of 2.3 Mb/s. Aside from the low hardware cost compared with other systems, it is also a lot faster (about 100 times faster than the Appletalk network). The cabling requirements are also very unsophisticated (Apple cable is more than adequate). The reason that the Transputer is used in parallel applications is because of these high speed links. On the Abaq jumpers

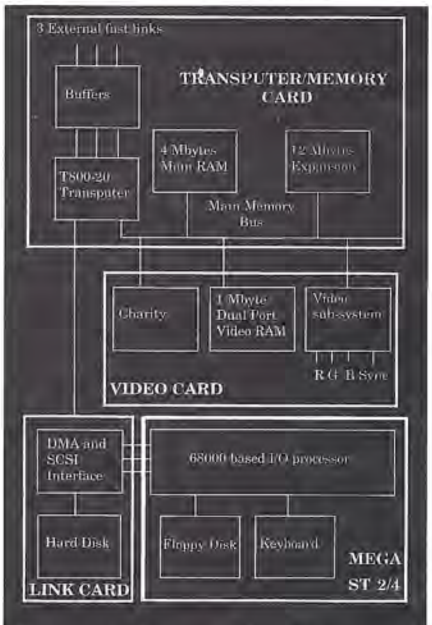

Figure 1: System Block Diagram

control the routing of these links. They can either be routed internally to add-in Transputer Farm cards or externally via TTL (4-pin mini-DIN) or ECL (9-pin D) buffered connectors. Link 0 also has the diagnostic and reset signals available for remote booting from the I/O processor (it is used for connecting to the Mega ST).

It is important to stress that external networking is available at no extra cost (apart from the cable) - it is part of the Transputer architecture.

Memory

The standard Abaq comes with 4 Mb of DRAM in the form of 32 socket mounted 1 Mbit chips. The really nice feature of the design is that memory refresh has been designed to take advantage of the new 4 Mbit chips as they become available (provided that they are pin compatible). In practical terms it means that with a simple chip replacement (for say £2000 @ £50 per chip) it is possible to upgrade the Abaq to 16 Mb (no extra boards!).

Processor/Memory Expansion

Add-in cards are already available for the Abaq from Perihelion. These fit into a vertically mounted expansion card capable of holding 3 cards. Various configurations are available. These may be extra memory (up to 12 Mb using 1Mbit chips) or extra Transputers complete with memory (up to 12 T800s with 1Mbyte each). Currently I have one extra T800 running at 20MHz with 1Mbyte DRAM. This took half-an-hour to fit (with a phone call to Perihelion hardware who have been very helpfull). Obviously, as 4Mbit chips become available, internal RAM expansion will take the machine to 64 Mb.

Other Expansion Options

Apart from the external availability of the Transputer links which allow the Abaq user to interact directly with devices such as the Meiko Computing Surface (offering supercomputer power), Perihelion also offer Ethernet and X.25 communication cards. This gives the Abaq user access to networks such as those that Sun, Apollo, etc use. Normally only one Abaq in a cluster of Transputer workstations need be connected to this other network since every other user may access it through the Transputer links (see later).

Perihelion also offers communication boards which will allow up to 16 asynchronous (RS232) type channels. The obvious application for these is the connection of dumb terminals, bar code readers, etc. These are hardware application areas which have traditionally required the use of expensive mainframes or mini computers.

Issue 4 Changes

Issue 4 machines will have a 20MHz

Processor	Clock	Whetstones/second single length
Intel 80286/80287	8 MHz	300K
IMS T414-20	20 MHz	663K
NS 32332/32081	15 MHz	728K
MC68020/68881	16/12 MHz	755K
ATT 32000/32100		1000K
Fairchild Clipper	33 MHz	2220K
IMS T800-20	20 MHz	4000K
IMS T800-30	30 MHz	6000K

Table 1: CPU Power

T800 fitted as standard (upping the performance by about 10%). In addition, 4 expansion slots will be available allowing up to 16 extra Transputers to be fitted internally (the power supply will be upgraded to suit).

The Video Card

So far the main technical advantage that the Abaq has over products such as add-in boards for PCs is the high speed communication with the I/O processor and built in SCSI interface. Where the Abaq excels is in its graphics capabilities and the price at which these become available to the user.

The video memory has been cleverly organised to take advantage of the capabilities of the Charity chip. It is physically organised as 32 64k X 4 chips. In mode 0 (4 bits per pixel) this means that Charity can write to a block of 8 by 4 pixels in one 32 bit wide write cycle. This is the key to the very high performance of the graphics in Pixel Block Mode (128 million pixels per sec [MPixel/s]). In mode 1, where each pixel is 8 bits deep, this is equivalent to a throughput of 64MByte/s (5 times faster than the T800, at least 10 times faster than most workstations).

Obviously it is desirable to write to this memory using the Transputer. Here again Perihelion has been quite clever.

Physically Charity can only refresh up to 64 Mb of memory so there is a lot of logical space left over. What Perihelion has done is to map the 1Mybte of video RAM onto 2Mbyte hunks of Transputer address space. Each of these maps may be used to correspond to each graphics mode of the Abaq (the space above location 0x00A0 0000 available for add-in video cards which migh offer, for example, 4000 by 4000 resolution).

The reasons for doing this are twofold. Although Charity is able to update VRAM in 4 bit chunks, the Transputer can only handle a minimum size of an 8-bit byte per instruction. In order to address a pixel at a time it is obviously desirable to use a single address to represent each pixel. This is what Map 0 provides. Every time you poke a location in this map with a byte value it strips 4 bits and shunts it into the video memory - hence the 2Mbyte logical address space.

In addition, Mode Independent Addressing is available. . Each location in the logical maps for Modes 1 and 2 is a byte deep. If this was mapped as mode 0 obviously 2 Mb VRAM would be required. In these modes Perihelion has 'shadowed the right hand side of the map so that a location on the 'shadow' is identical to a location on the main 1024 by 1024 map (Column 1536 is identical to column 512). In practical terms this means that applications designed to run in Mode 1 will display correctly in Mode 0 (and vica versa provided Mode 0 applications do not write to beyond column 1024). Mode 1 can display 1024 by 768 of this Map at any one time whereas Mode 2 can only display 640 x

480. Because two physical screens can fit into this latter map it is the mode most suited to animation (with rapid switches between logical screens).

Video Sub-system

The video sub-system is primarily concerned with getting pictures to the screen and displaying colour. As table 2 indicates the Abaq supports quite a range of colour options. This is all logically controlled through DACs, CLUTs, and the frame buffer.

DAC stands for Digital to Analogue Converter and there is one DAC for each of the red, green, and blue, guns of the monitor. In mode 0 each DAC can send out 16 different levels of intensity (see Figure 2). Since there are 3 guns there are 16 x 16 x 16 possible combinations - hence the 4096 colours to choose from. In modes 1, 2, and 3 the Abaq uses 8-bit DACs. Each DAC can handle 256 levels of intensity hence the 16.3 million colours (256 x 256 x 256).

The CLUTs, or Colour Lookup Tables, operate as indicated in Figure 8 for Mode 0. The CLUT may be considered a 16 by 3 array. Each of the 16 rows holds values corresponding to the settings that the DAC can handle. The CLUT operates by being supplied with the row index and issuing the values to each DAC.

The reason that this is done is because the Mode 0 Frame Buffer (Video RAM) can only handle 4 bits (or 16 variations) at each pixel. Each pixel acts as an index to the CLUT which sends the values to the DAC - hence 16 at any one time out of a total choice of 4096. In order to change the colour in the CLUT all you have to do is to poke new values for each gun into the appropriate entry. The CLUTs, like everything else on the Abaq, are mapped to the Transputers address space - so it is very easy to do.

Modes 1 and 2 operate in exactly the same way except that they use 8 bit DACs, a 256 row CLUT, and 8-bit pixels. The Mode 3 frame buffer is able to handle 32 bit values. Obviously this is capable of storing the full range of the DACs (3 x 8 bits) so a CLUT is not necessary - hence 16 million colours. 7 of the remaining 8 bits are for use by the programmer, the 8th being used to set all white.

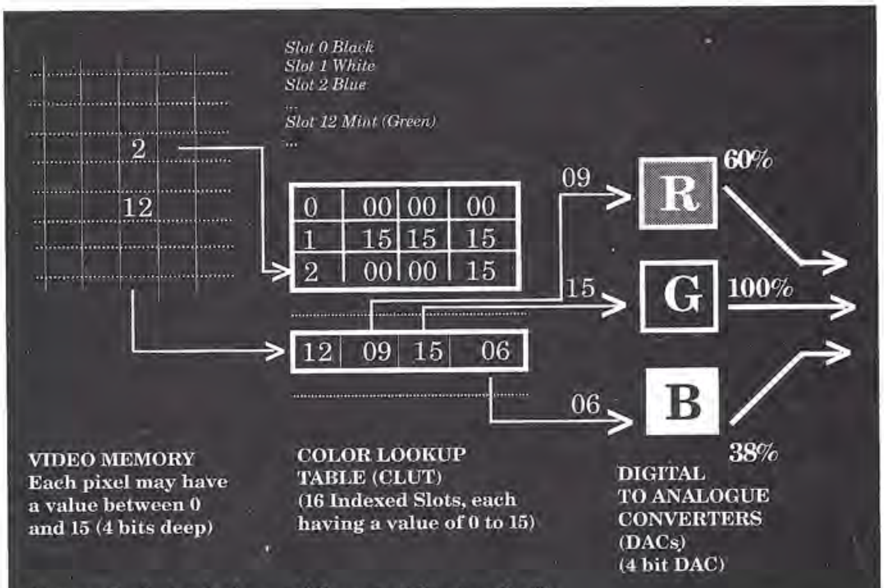

Figure 2: Color lookup table operation (mode 0)

The best way to see the effect of all of this is to load random values into the CLUT and display a colour map. [Source available from the author].

Cambridge Charity

Charity has been referred to as a Blitter. This is really a bit of an understatement since a BitBLT operation simply involves moving blocks of bytes from a source to a destination - Charity is a lot more sophisticated than this (Charity derives its name from the fact that Perihelion felt that Atari recieved a lot better chip than they paid for, the extra features being given away as 'charity').

The features of Charity may be summarised as follows

* 32 bit data path allowing 8 pixels to be operated on at the same time in Mode 0 and 4 pixels in modes 1 & 2. (Traditional blitters can only handle one pixel at a time)

* Variable sized destination and source areas

* Overlapping source and destination areas. This allows for small movements in any direction (most blitters can only handle different area locations resulting in substantially more work to do small movements)

* Pixel alignment

* There are 4 tests carried out on each pixel at the same time (With the source and destination compared with each other or with 2 out of 4 dedicated registers for comparison operations. Most blitters only handle source/destination comparisons)

* These tests do a value comparison (greater than, less than, equal to, or any combination) (Most blitters only act on zero or not zero)

* Special memory addressing provides for the high speed Pixel Block Mode described previously.

* Able to address up to 64 Mb user RAM in addition to video RAM (Most blitters can only work within video RAM). This feature allows Charity to be used to do things like very fast pattern matching (important in Artificial Intelligence applications).

These features provide the 'meaningful operations on CLUTs' which people are so fond of stating. In practice it makes for very fast window operations, animation, character drawing, etc - much faster than many dedicated graphics processors for the above operations.

Expansion possibilities

Atari/Perihelion are ensuring that 3rd parties can upgrade even this specification by the provision of a Video board expansion slot - so do not be surprised to see higher resolution and more colour on the Abaq in the future.

e) Issue 4 Changes

The main logical changes to the Video system will be to Charity. Although not finalised the specification for Charity II (or Blossom as it will be known as) includes the following additional features :-

* Hardware trapezium filling (up to 32MPixel/s in Mode 0) - the best the Transputer can do is about 6MPixel/s).

* Hardware line drawing

* Co-ordinate mapping (ie. specific X-Y coordinates rather than memory addresses.

* 32 pixel mask register set (for adding further graphics effects)

* Selective write operations after comparisons (True, False, write specified colour, etc)

These extra features are very important to normal graphics operations since a lot of load is taken of the host processor. This is in addition to the higher speed of graphics operations. In practice this means that graphics will be at least 5 times faster than is possible with a T800. As we will see later this will make the Abaq probably the fastest X-Windows engine on the market (by a long way!).

Unfortunately, because of these forthcoming changes, Atari and Perihelion have not used Charity for graphics in any of the current software - they are using just the T800. This does not mean to say that graphics are slow - far from it - the T800 is still very fast. It is just that graphics currently run at least 5 times slower than will be possible on Issue 4 machines.

Physical changes to the board are also due :-

* Most of the board is to be replaced by a chip called Dylan.

* The monitor connections will be reduced to a single set.

Observations in use

These are already reliable boxes. My machine operates for about 11 hours a day, 5 days a week, none stop. I have had no hardware problems.

I am currently using an NEC Multisync Plus which (at £800) is more than adequate for Modes 1, 2, and 3. Toward the end of the year multisync colour monitors able to display the full 1280 x 960 mode are likely to be available for about £1500 (Hitachi appear to be front runner in this race at the moment).

Alternatively Phillips do a very nice monochrome (shades of grey) 1280 x 960 monitor for about £300 ($450). Of course - if you are happy with that boring VGA graphics standard, Modes 2 and 3 can be displayed on the standard Multisyncs (at about £350 - $525). The message in this - monitors are not going to cost you the £5000 ($75000) that some writers have been suggesting!

Availability has not been perfect, but demand has, I am told, exceeded Atari's ramp-up scheduling. In the first week in July Atari finally completed assembly of the 50 machines which had been due to go out at the end of April (2 months late). Having said this Perihelion has been very active in designing the new chips and the new forecast date for the first batch of Issue 4 machines is now to be October (one month later than previously stated). In practice Abaqs are unlikely to be available in vast numbers until Christmas.

Having said this, the Abaq represents an order of magnitude jump in price/performance over other latest generation workstations - it will take competitors quite a while to catch up.

Lotsa money?

The recommended retail price for the Issue 3 Abaq consisting of link card, 4 Mb DRAM, T800 Transputer, 1 Mb Video RAM, video sub-system, etc is £2999.99: Atari offers a good discount to developers.

Given falling memory prices, falling Transputer prices, the massive reductions in chip count, and relatively low overheads, there is no reason why the complete Issue 4 Abaq (complete with I/O processor board and 40 Mb hard disk) should not fit within the £3000 target. Even in pre-production form it represents exceptional value for money.

Down the road...

Perihelion has been thinking along the lines of producing a low cost 'transputer terminal' for some time. This is an attractive option since it would then be feasible to purchase additional Transputers for use by typists and other low resource users. The availability of these extra processors would of course add to the supercomputing possibilities of the network. Do not be too surprised if these appear sometime next year.

Perihelion and Atari are very committed to this project - since Perihelion has also developed very competitively priced Expansion boxes (holding up to 12 of its Farm cards) it are likely to be quite a force in its own right - they certainly have a strong team. It is very unlikely that the ATW will die (as some observers have suggested). And remember - the link between Atari and Perihelion extends to the Atari ST lapheld shortly to be released.

About the author: Mike Charnely-Fisher is an electronics engineer, programmer and metallurgist whose day-job is with an International engineering company based in North London, UK. He's a passionate evangelist for parallel processing, and looks forward to making his own contribution to the body of knowledge available. A member of the UK Transputer Users' Group, Mike's own embryo corporation, Workstation Development Systems, is planning add-on products for Transputer-based workstations, starting with the Atari machine - which is why he knows it so well. Mike can be contacted on [+44] (0)494 783594.