LAMBDA MACHINE OVERVIEW

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LMI

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The major design philosophy of the Lambda machine is the concept of modularity. The system is designed so that it can exist in a large number of configurations centered around a 32 bit high performance bus. The motivation for this philosophy is the desire to move away from the conventional notion that a computer maintains a stagnant design, fulfilling needs for only one specific task. The Lambda machine provides a hardware environment for the customization of a computer system so that Lambda configurations are flexible enough to address many different applications.

Installations can choose either a LISP processor, a 68000 based UNIX processor, or both. Memory, network interface, video, and disk are all added as the application dictates; simply by plugging the appropriate cards into the bus.

Architectural extensibility is made possible by the System Diagnostic Unit, a single board which links the system 32 bit NUBUS with an industry standard MULTIBUS. The microprocessor driven SDU provides both front panel operations along with basic diagnostic capabilities. The SDU senses what types of devices are installed in the Lambda machine and conforms system operation to execute in concert with the hardware configurations.

By providing an architectural supervisor within the mainframe, the Lambda releases system designers to solve application problems. Problems of integration, configuration and maintenance are no longer hurdles in providing computer solutions to specific application areas.

LISP PROCESSOR

The design of the LISP processor significantly upgrades the performance of the present CADR Machine while maintaining a high degree of software compatibility. The processor is available in two configurations:

1. 32-Bit Configuration - This configuration is identical to that of the present LISP Machine, having a 32 bit word length which contains a 24 bit pointer, five bits of data type and three bits of special storage information. This processor, while operating at considerably higher speed (around 3 - 5X) will run the identical software as the CADR.

2. 40-Bit Configuration - An optional configuration for the processor will be a 40 bit machine which will extend the pointer size and, hence, the addressable virtual memory to 32 bits. The remaining eight bits are unchanged for the existing machine. In this manner, there will be maximum possible software compatibility with the existing design while substantially increasing the amount of addressable memory in the machine. This configuration furthermore expands the maximum integer and floating point number size to 32 bits which has allowed the implementation of the IEEE floating point standard. The hardware is designed so that this functionality increase will not sacrifice machine speed and the 40 bit version will, therefore, run at the same rate as the 32 bit version. As the tag bits have a fixed field regardless of the data type, substantial microcode changes will not be needed. Furthermore, the 40 bit configuration maintains a byte orientation and, therefore, no changes to devices such as peripheral controllers will be necessary.

Both configurations of the processor reside on four boards and have a 4K cache. Users have access to a 64K user-writable virtual control memory.

Motorola 68000 Processor

In addition to the LISP processor, the Lambda machine also offers a processor configured with the 10 MHZ version of the Motorola 68000 chip. This processor is configured with a 4K cache and executes the UNIX operating system providing processor speeds of about 1 MIP. 68000 UNIX supports a multi-user/multi-process environment, virtual memory via demand paging, and is based on Berkeley-UNIX now available on VAX systems. Because Berkeley-UNIX was chosen, migration of existing programs under VAX UNIX is exceedingly easy with the majority of existing programs requiring only recompilation.

The initial software includes:

- C
- PASCAL
- Fortran 77
- Window System
- Several screen editors, including EMACS
- SIGGRAPH core library of graphics programs (level 1)
- Network software providing mail, remote file transfer and remote login under ETHERNET II

User programs executing under UNIX are able to address a full 24 bits of virtual memory.

It should be noted that this processor is not intended as a LISP processor. The LISP processor is a different set of boards which can be used instead of, or in addition to, the 68000 processor. The two processors will function independently but will have access to process-to-process communication primitives linking LISP and UNIX.

Video Controller and Display

The standard video monitor for the Lambda machine is a high resolution black and white CRT (1024 x 800 pixels). The screen is non-interlaced and refreshes at 60Hz for flicker-free operation. Optional displays include both standard and high resolution color.

LMI is also offering its video switch (now available on its CADRS). This option allows the interface of up to four Lambda machines to up to eight consoles. While this option does not in itself provide a timesharing facility to the Lambda machine, it does allow users to maintain their own console and to interface to a free machine when one is available.

Keyboard

There are 100 physical keys on the keyboard providing a superset of ASCII. The keyboard has unlimited rollover, meaning that a keystroke is sensed when the key is depressed no matter what other keys are depressed at the time. The hardware can tell exactly what physical keys are being pressed at any given moment; it knows when any key is depressed and when it is released, which means that the machine could be programmed to interpret the keyboard in any manner whatsoever.

Memory

The basic Lambda machine is configured with one megabyte of error correcting memory, configured into 32 bit words. Physical memory can be expanded via the installation of additional memory boards.

The Mouse

The mouse is a point device that can be moved around on a flat surface. These motions are sensed by the machine, which usually responds by moving a cursor around on the screen in a corresponding manner.

There are three buttons on the mouse which are used to specify operations to be performed. Typically the user points at something with the mouse and specifies an operation by clicking the mouse buttons. Rapid double clicks are conventionally distinguished from single clicks. Thus, in any specific context there are up to six operations that can be performed with the mouse invoked by Left, Left Double, Middle, Middle Double, Right and Right Double clicks.

Serial Interfaces

A basic Lambda configuration will include three RS232 interfaces, two residing on the System Diagnostic Unit and one on the display console. Additional interfaces are available, plugging into the MULTIBUS.

Network Interface

Lambda installations are supplied with an ETHERNET II interface executing the Arpanet TCP/IP protocols.

Disk Control

The disk control is provided by an SMD type controller which will be able to connect to a variety of commercially available disk drives. The standard drive of the Lambda system is a 470 Mbyte Winchester Drive.

Hybrid Configurations

One of the more exciting aspects of the Lambda machine is the interfacing both LISP and UNIX computation. Systems configured with both processors have the ability to communicate on a process-to-process basis utilizing the system defined STREAMS/PIPES interface. Typical applications for this configuration are to utilize the UNIX processor as a multi-user front-end to package and send requests to the LISP processor. LISP would then provide the specific symbol manipulation aspects of the problem solution and return its result to UNIX. This approach would provide an effective multi-user interface slaving LISP processor. Other configurations can include networked systems of both dedicated LISP and dedicated UNIX processors. In this way, an initial purchase of a specific workstation can easily be upgrade to include both capabilities.

Conclusion

Overall, the LMI Lambda machine represents a sizeable jump in technology while providing quite a cost savings over the earlier CADR machine. LMI will start deliveries in June, 1983.

ETHERNET II - TM Xerox Corporation
UNIX - TM Bell Laboratories
VAX - TM Digital Equipment Corporation

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LAMBDA SYSTEM SPECIFICATIONS

1. NUBUS:

- High bandwidth, synchronous bus.
- Multiprocessor architecture.
- Write interrupt structure within bus address space.
- Block mode transfer.
- Additional private buses can be declared.

2. LISP PROCESSOR:

- Executes LISP Machine LISP.
- Standard processor: 32 bit word, 67 megabyte virtual address space.
- Mir.or cycle rate 20 MHZ (50 nsecs).
- 4K x 32 bit cache.
- 4K A and Dispatch memory (combined).
- 4K M and PDL buffer memory (combined).
- Hardware assist for tagging and detagging.
- Hardware assist for macro instruction decode.
- Improved virtual memory management.
- 64K x 64 bit virtual control store (resides in 16K of physical control memory).
- 16 x 16 hardware multiplier matrix.
- Optional 40 bit processor, 21.5 gigabyte virtual address space, 32 bit single word arithmetic.

3. 68000 PROCESSOR:

- 10 MHZ version.
- 4K cache.
- Peak speeds of 1 MIP.
- 24 bit virtual address space.
- Demand paging.
- Native software system is Berkeley-UNIX (multi-user, virtual address space. Initial software supported: C, Pascal, Fortran 77, EMACS, Window system, Internet software, Siggraph graphics library).

4. SYSTEM DIAGNOSTIC UNIT:

- 8088 microprocessor.
- Two RS232 interfaces.
- MULTIBUS interface.
- ¼" tape streamer interface.
- Able to access all system components dynamically providing both front panel and diagnostic functions. As a result, there are no DIP switches or jumpers within Lambda.
- Typical functions are to boot processors, allocate physical memory, partition disk, sense what is plugged into NUBUS and assign bus addresses.
- Used in setting up process communication primitive between LISP and UNIX by defining common memory area for both processors to exchange information (STREAMS/ PIPES interfaces).
- Not intended to execute user programs (as in the case of the LISP or 68000 processor).

5. CARD CAGE:

- Twenty-one slots, 13 NUBUS, 5 MULTIBUS, 3 slots either MULTIBUS or NUBUS.

6. CABINET:

- 19" rack mount 60" x 35" x 22.5".

7. POWER:

- 110 volt AC, 30 AMP, 60 HZ.

8. HEAT DISSIPATION:

- Approximately 6400 BTUs.

9. ENVIRONMENT:

- Between 55° - 88° F., humidity 10 - 80% non-condensing.

10. SYSTEM CONSOLE:

- 800 x 1024 black and white, choice of standard ASCII or AI keyboard, 3 button mouse, one RS232 interface, operational up to 200 feet from mainframe.
- System will accept multiple consoles (high resolution black and white display, keyboard and mouse), high and medium resolution color and video frame-grabber.

11. DISK:

- 300-500 megabyte Winchester, SMD controlled (SMD will hold up to 8 diskes per controller). Removable media drives also available.

12. NETWORK:

- ETHERNET II (10 megabits)using Arpanet TCP/IP protocols. Accessed from either or both LISP and UNIX.

13. MEMORY:

- 300 Nsec peak access time, error correcting.

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