RIP Architecture

A raster image processor (RIP) is a computer with a very specific task to perform. It translates a series of computer commands into something that an output device can print. For an imagesetter, this means the instructions that instruct the laser to expose certain areas on the film.

RIP architecture refers to the design of the RIP, particularly the hardware and software that make the RIP work. It is impossible to discuss RIP architecture without mentioning a number of computer buzz words[1], many of which are acronyms (see list to right). And so to begin, we'll start with a review of computer basics, and see how those principles apply to RIPs.

Acronyms

ASIC	Application Specific Integrated Circuit
CISC	Complex Instruction Set Computer
CPU	Central Processing Unit
EPROM	Erasable Programmable Read-Only Memory
I/O	Input/Output
MHz	Megahertz
MIPS	Million Instructions Per Second (also the name of a company that manufactures CPUs)
PROM	Programmable Read-Only Memory
RIP	Raster Image Processor
RISC	Reduced Instruction Set Computer
SPARC	Scalable Performance ARChitecture
TAXI	Transparent Asynchronous Xmitter receiver Interface
XMO	eXtended Memory Option

[1]An excellent source of information on computer technology is *The Computer Glossary* by Alan Freedman. It is available from The Computer Language Company, (215) 297-5999.

Computer basics

The **CPU** of a computer is where the bulk of the computing gets done. The CPU may also be called the **microprocessor** if the CPU is built on a single miniaturized electronic circuit (i.e. chip). A listing of well-known microprocessor designations is shown to the right.

A **motherboard** is the main printed circuit board in a computer. It contains the CPU as well as interfacing circuitry for external devices (keyboard, monitor, etc.). One key characteristic of a motherboard is that it has slots to accept additional **removable printed circuit boards**. (See Figure 1.) These slots are usually named according to the type of bus[2] that the computer uses. Though the main CPU is on the motherboard, removable printed circuit boards may also have their own CPUs.

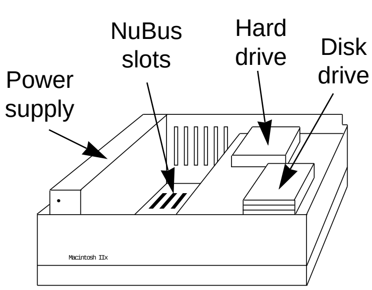

Figure 1 - Macintosh IIx showing NuBus slots in the motherboard for the placement of daughterboards.

[2]A bus is simply a pathway within a computer which links internal components. NuBus, EISA, and VME are industry bus standards.

The speed with which a CPU can process data is called **clock speed** and is usually measured in megahertz (MHz). **MHz** is the number (in millions) of cycles per second

Microprocessor designations

Intel Corporation
- 8080, 8088
- 8086, 80286, 80386, 80486
- i960

Intergraph
- CLIPPER®

MIPS
- R3000, R3010

Motorola
- 88100, 88200
- 68000, 68010, 68020, 68030, 68040

Sun Microsystems
- SPARC®

Besides being used in RIPS, Intel microprocessors are also used in IBM and IBM-compatible PCs. MIPS microprocessors are also used in Silicon Graphics workstations. Motorola® microprocessors are also used in Apple Macintoshes®. Sun microprocessors are also used in Sun workstations.

that the computer processes. Common clock speed values are 25, 33, 40, and 66 MHz. Also important in terms of CPU performance is the number of instructions per second that it can handle (often called **MIPS**). MIPS values vary from .05 to 100 or more. (This equals 50,000 to 100,000,000 instructions per second). However, while these numbers are important, they do not always give a good indication of how fast a PostScript job will run on a given RIP. Many other factors play a role in overall computer speed. This is why benchmarks tests are so important.

An **ASIC** is a customized computer chip that is created from a variety of pre-existing circuits. This makes ASICs easier to create than designing a totally new chip. ASICs are designed to perform very specialized computing tasks. TurboPix®, Linotype-Hell's proprietary screening accelerator, is an ASIC, as is Adobe System's display-list rendering co-processor PixelBurst™.

A **PROM** is a permanently programmed memory chip. PROMs have commonly been used to distribute software updates in a form that is not easily duplicated. An **EPROM** is a PROM that may be erased and reused. PROMs and EPROMs have commonly been used to distribute software updates in a form that is not easily duplicated. PostScript™ revisions were installed into Linotype-Hell RIPs via EPROMs until the introduction of the RIP 30, which has a floppy drive for receiving software updates.

CISC and **RISC** describe the sets of instructions that are built into the computer. RISC computers are designed to accelerate the processing of the most commonly used instructions. CISC computers, on the other hand, run all instructions at the same rate. RISC is an advantage in certain compute - intensive tasks, but for other tasks (like the processing of halftones) RISC will not be faster than CISC. (This is why screening accelerators like TurboPix are so important).

Communication of data is also important and can be categorized as follows:

- *Communication of data inside of the computer along the bus.* This occurs along a data path which is described by the amount of data it can handle, for example, a 16 bit data path.
- *Communication between a RIP and a workstation (or several workstations on a network)*. EtherTalk® and LocalTalk® are commonly used for this. Centronics® and RS232 also fall in this category.
- *Communication between the RIP and recorder (this is often called the video channel)*. LI-2, LI-5,[3] and TAXI are commonly used for communication of video data and control commands between a Linotype-Hell RIP and recorder.

[3]For more information on LI-2, LI-5, Centronics, EtherTalk, LocalTalk, and RS232, please refer to the Linotype-Hell technical information piece entitled Troubleshooting PostScript Errors.

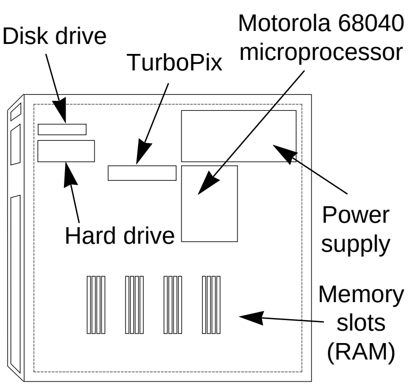

Figure 2 - Inside view of a RIP 40 XMO TurboPix.

Finally, you may hear RIPs described as interpreters or controllers. Strictly speaking, an **interpreter** is the software used to translate a computer program into machine language. A **controller**, on the other hand, is the hardware that controls peripheral devices (in this case, the output device).

An example

To give you an idea of how these terms come into play, let's look inside a Linotype-Hell RIP 40 XMO TurboPix. (See Figure 2.) The CPU in a RIP 40 is a Motorola 68040 microprocessor. The RIP 40 contains an ASIC, called TurboPix, for accelerating contone screening. It has a floppy disk drive for receiving PostScript revisions.

Different kinds of RIPs

Within the Linotype-Hell product line there are RIPs of many different types. This diversity of RIPs points out the need for matching the RIP with the type of work that that RIP will perform best. RIPs may be divided into three categories: software, board-based, and hardware[4].

[4]Adobe Systems, Incorporated defines a hardware RIP as a custom computer system that runs only one program. A software RIP, on the other hand, runs on a standard workstation and is just one of the programs running on that system. In the case of a software RIP, the computer the RIP runs on could conceivably be used for other functions besides ripping.

A **software RIP** typically runs on a Macintosh, PC or Unix® workstation. The speed of a software RIP will improve with a speedier computer (although that doesn't necessarily mean that a computer that is twice as fast will process jobs in half the time.) Software RIPs run the gamut from low-end devices primarily for black & white work to more sophisticated devices. Software RIPs are easy to work with and upgrade, but they may not be well-suited for handling large files or color images. The performance of software RIPs may be improved through the use of accelerator cards. Accelerator cards are removable integrated circuit boards which fit into the computer on which the software RIP runs. A software RIP specifically for the processing of synthetic line art is a part of Linotype-Hell's ScriptMaster™ product.

Board-based RIPs, like the Linotype-Hell RIP 20, are really a combination of a hardware and software RIP. The board-based RIP is manufactured, in the case of the RIP 20, to fit in the NuBus slot of a Macintosh. This allows the Macintosh to be used simultaneously as a front end workstation and as a RIP. In the RIP 20, the microprocessor in the board of the RIP 20 is an Intel i960 RISC processor. The RIP 20 board is an example of a removable integrated circuit board with its own CPU and RAM.

Hardware RIPs like the Linotype-Hell RIP 40 XMO TurboPix, RIP 50 and RIP 60 are designed to handle particularly compute-intensive tasks in hardware. This offers great potential for speed gains. For example, the RIP 60 has three CPUs, each of which is dedicated to a different function (see Figure 3):

- a Motorola 68000 for transmission of data to the recorder
- a Motorola 68030 for I/O, networking, terminal tasks, and transmission of data from the front end
- a Motorola 68040 for interpreter tasks and rasterization

The three removable integrated circuit boards in the RIP 60 are attached via a VME bus. Their work is complemented by that of a screening computer. Hardware RIPs provide an optimal platform for accelerating RIP performance.

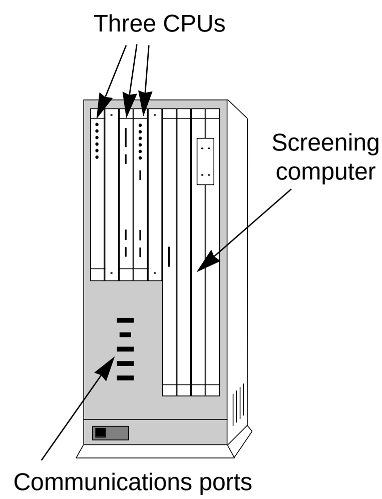

Figure 3 - Rear view of a RIP 60.

Bottlenecks

To understand what makes a RIP fast, you need to know something about the things that can slow it down. In the early days of the PostScript page description language, the implementation of the language itself was pretty slow, and thought to be a big problem. But improvements in the language focused the problem on the hardware used in the RIPs. As more color scans were output, movement of large files around a network became an issue. And now, as RIP speeds continue to increase such that the RIP may supply data faster than the imagesetter can record the data, the recording speed of the imagesetters themselves becomes an issue. And yet as RIP speed improves, RIPs are also being asked to perform more complex duties (for example, imposition, trapping and color space transformation).

Improving RIP speed is a never ending struggle. Solve one bottleneck, and you discover two more. The list of potential bottlenecks includes:

- The RIP architecture
- Imagesetter recording speed
- The page description language (i.e., the quality of the interpreter code)
- The printer driver[5]
- Communications and networking issues
- Software applications and the quality of the code they create
- Hard drive access times
- Amount of RAM installed

[5]A printer driver is a program that lets files be exchanged between a workstation and a peripheral like a RIP.

In addition, each file run on a RIP could be graded in complexity based on a variety of factors including the number of fonts, the complexity of synthetic artwork, the file size of scans, the inclusion of nested files or rotated scans, complex clipping paths or patterns, spot color, process color, etc. The more complex the file, the longer it could take to run.

Conclusion

Obviously, RIP architecture is a very complicated subject and could warrant many pages of description. For this reason, a number of important issues related to RIP performance (for example, page buffering, multiplexing, and I/O pipelining[6]) will be investigated in future articles.

[6]Input/output pipelining improves throughput in the Linotype-Hell RIP 50 by using a 100MB buffer. This buffer allows the second page in a multiple-page job to be processed at the same time that the first page is being output. This increases the productivity of a workstation by transferring multiple page jobs quicker, thereby freeing the workstation for additional work.

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