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New Chip Set Shrinks Laser Printer Designs

Destiny Announces All-in-One Chip for i960-Based Printers

By Linley Gwennap

Destiny Technology, which introduced the first HP-compatible laser-printer chip set, is now shipping a new product called "All-in-One" that integrates the system logic of a typical laser printer into a single chip. Combined with an Intel 960 processor, the new chip forms the core of an off-the-shelf printer controller that can fit on a 30 in² (5.5" × 5.5") board. The same board can also include Destiny chips for accelerated font rendering ("RIDA") and for edge enhancement ("EET").

The Destiny chips allow vendors to enter the fast-growing laser-printer market with low up-front design costs. With similar features as products from Hewlett-Packard, the market leader, the chips let these new vendors go head-to-head with HP. Just as Chips and Technologies' first PC chip set leveled the playing field and destroyed IBM's near-monopoly position, the Destiny chips could eventually reduce HP's dominance unless it can continue to out-innovate its competitors.

Destiny's products also bolster the i960 in its battle against the Am29000 and other CPUs to control the next generation of laser printers. AMD's strategy with its 29200 family is to integrate basic system logic onto the processor itself (see [070702.PDF](#)), but AMD does not offer features such as hardware font rendering and resolution enhancement. These features are important to compete in today's printer market.

According to InfoCorp, nearly 3 million laser printers were sold in the US alone last year, representing a 27% increase over 1991 shipments. HP and Apple accounted for 51% of those sales using in-house chip sets. The rest of the market was split widely among many companies, and several new vendors have entered the market in the past year. This influx of vendors has fueled the demand for standard, off-the-shelf controller designs.

Destiny began life as a printer manufacturer but, in 1989, decided to market its software and hardware components to other printer vendors. It now offers ASICs and drivers with a feature set comparable to HP's Laser-

Jet printers. The company's biggest announced design win is with NEC, but Destiny claims it has wins at 11 of the top 15 laser-printer vendors. The company dominates the market for printer chip sets, particularly for products that use HP's PCL (printer control language). Its only significant competitor is Phoenix, which has been successful mainly in Postscript printers.

All-in-One System Logic

Figure 1 (see below) shows a block diagram of a laser-printer controller using Destiny's chips. The diagram is similar to a notebook PC: high-speed devices sit directly on the processor bus, while the system-logic chip provides DRAM control and built-in I/O such as serial and parallel ports. Instead of a monitor, video output goes to the laser engine.

Of course, the details are quite different. Laser printers commonly use processors in the 68000, i960, and Am29000 families. The All-in-One chip, or 8905, supports most i960 processors, including the low-cost i960SA (see [μPR 10/17/90](#), p. 15), the mid-range i960KA (see [μPR 4/88](#), p. 1), and the high-end i960CA (see [μPR 9/89](#), p. 1). The processor bus is either 16 bits (for the SA) or 32 bits. The 8905 supports processor-bus speeds up to 25 MHz, suitable for all but the fastest i960CA chips, and supports i960 burst-mode transfers.

The i960 can directly access ROM chips on the processor bus. This memory is typically used to store the basic control program, control-language interpreters (such as PCL or PostScript), and built-in fonts. Many printers have provisions for adding a font cartridge that contains additional ROM data.

The 8905 controls up to 64M of DRAM, which is primarily used to store incoming data and build page images. It supports both 16-bit and 32-bit DRAM interfaces, matching memory width to that of the processor bus. A low-cost system might have 1M of memory using two 256K × 16 DRAMs.

The 8905 includes a DMA controller used primarily in AppleTalk systems. Other system-logic functions such

as interrupt control and timers are also offered.

The All-in-One lives up to its name by incorporating a variety of standard peripheral interfaces. Most laser printers connect to the host system using either a serial or parallel port; signals for both are included in the 8905. To improve data flow between the parallel port and the main memory, byte-packing logic groups incoming data to take best advantage of the wide memory path.

The chip also provides six general-purpose I/O pins that can be used to control the buttons, lights, and LCD character display on the printer's front panel. Since many printers store configuration information in non-volatile memory, a serial NVRAM interface is available.

Finally, the 8905 generates all of the control signals for a Canon-type (or similar) laser engine. It controls engines of up to 600 dots-per-inch (dpi) resolution. To accelerate image generation, the chip incorporates a BitBLT engine (similar to a PC graphics chip), a 16 x 16 pixel rotation engine, and hardware image expansion with a "smoother" that converts 300-dpi images to 600-dpi resolution.

Raster Acceleration

Destiny's Raster Image Device Accelerator (RIDA) chip is an optional system component that speeds the rendering of outline fonts, line art, and halftones. Outline fonts have become more popular than bitmap fonts because they can be scaled to any size. Instead of representing a character using a grid of points, an outline font uses a mathematical description of lines and curves to form a character. Popular outline-font definitions include TrueType, (used by Apple System 7 and Microsoft Windows) and Type 1 (used by Postscript).

RIDA acts as an independent coprocessor. It takes the requested character code, font, and point size from the page description and calculates an image of the requested character based on the appropriate equations. These equations, which define a particular outline font,

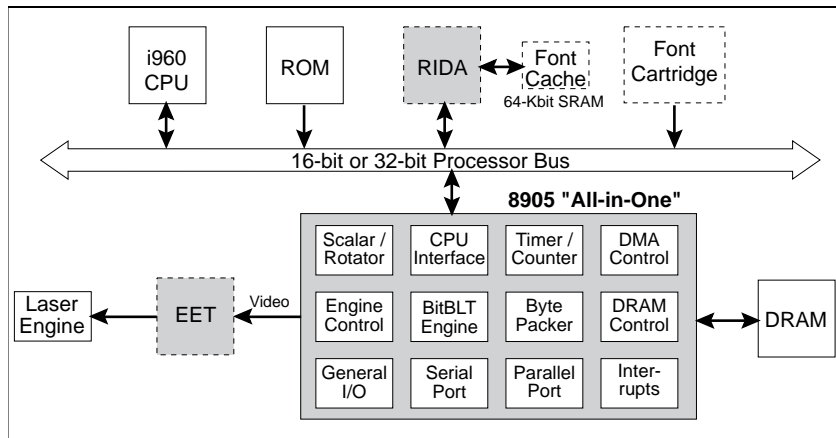


Figure 1. Block diagram of a laser-printer controller using Destiny's chip set including the new 8905 (system logic), RIDA, and EET chips.

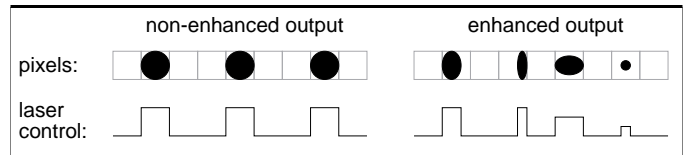


Figure 2. Altering the timing and intensity of the laser pulse changes the size, shape, and location of the dots on the paper.

are usually held in the font ROM.

An on-chip microcontroller oversees the rendering process. For each character, the chip first maps the specified equations onto the desired coordinate grid. The curves are then "flattened" into short line segments. The next step is to fill in the outline, which involves dividing the inside of the character from the outside. The final character is then translated into a bitmap before being transferred to main memory.

The chip uses a small local memory to hold the current character. This memory is a 64-Kbit SRAM, large enough for a 256 x 256 bitmap, which corresponds to about a 32-point character at 600 dpi. Larger characters are rendered using a "striping" technique.

Destiny claims that its RIDA chip can render 7500 12-point characters per second at 300 dpi, enough to fill two average pages. This is far faster than needed to keep up with a low-cost six-page-per-minute (ppm) laser engine but is just adequate for a more costly 12-ppm, 600-dpi engine when using smaller fonts.

RIDA can also accelerate line-art drawing with its ability to quickly calculate and plot lines and curves. Its internal engine can accept Bézier curves, splines, and vectors.

Edge Enhancement Technology

Hewlett-Packard first popularized the concept of resolution enhancement in the LaserJet III with its proprietary RET (Resolution Enhancement Technology). The idea is to program the laser engine to alter the size and shape of the dots by varying the pulse width and intensity of the beam, as shown in Figure 2.

Figure 3 shows how this technique can simulate finer resolution. The LaserJet III, for example, uses a 300-dpi engine to generate images that approach 600-dpi quality.

Destiny delivered its EET chip, which performs a similar function to HP's RET, just six months after the LaserJet III was introduced. The second-generation EET chips, introduced last year, work with 600-dpi engines to produce 1200-dpi images. The chips intercept some of the engine-control signals from the 8905, as shown in Figure 1, and modify them to improve the apparent resolution. Ten internal registers store configuration values that can be tuned for any partic-

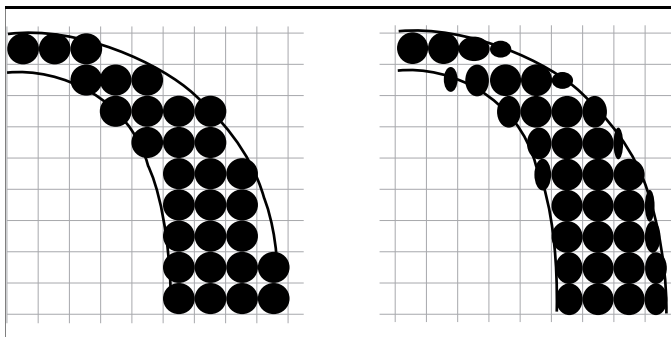


Figure 3. Without enhancement, a curve printed using a 300-dpi engine appears ragged (left), but with Destiny's EET, the same engine displays a much smoother curve (right).

ular laser engine.

The same technology also improves the appearance of half-tone images, which portray various shades of gray. To create the appearance of gray, a laser printer typically groups a set of dots into a "macropixel" and turns on a percentage of the dots in the macropixel that corresponds to the desired shade of gray. Figure 4 shows non-enhanced 600-dpi output using a five-dot macropixel to simulate six shades of gray.

The EET chip can achieve a similar effect using a 300-dpi engine by varying the size of the printed dots. In fact, it can produce ten or more discernable shades of gray in this way, approaching the quality of halftone images produced on a non-enhanced 1200-dpi engine.

Destiny has also added features that reduce artifacts such as "streaking." In a large area of 10% gray, for example, a regular dot pattern can result in apparent stripes of dark and light. EET examines adjacent pixels to detect such situations and alters the location and shape of the dots to avoid these problems.

Conclusion

Destiny's 8905 reduces the size and cost of the controller board for a low-end or mid-range laser printer. A printer vendor can use a single controller board for a variety of performance points simply by leaving room for the optional RIDA and EET chips. The chip set is not as good for high-end "workgroup" printers—those that churn out at least 15 ppm—but these printers represent less than 5% of total laser-printer sales.

The biggest growth has been in sales of "personal"

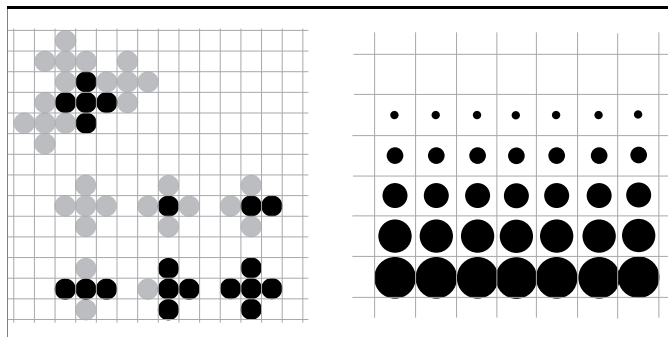


Figure 4. A normal 600-dpi engine uses a five-dot "macropixel" to print six shades of gray (left). With EET, a 300-dpi engine can display the same six shades with a single pixel (right).

printers—rated at 6 ppm or less—and this area is also where HP's leadership is weakest, at about a third of the market (according to InfoCorp). Destiny's chips are well-suited for these products, and the company can deliver the hardware and software needed to match the feature set of competitive printers. Thus, to enter this market, all a potential vendor needs to add is standard components such as an i960 processor, memory, and a laser engine from Canon or a number of other suppliers.

As the printer market continues to evolve, higher-resolution and multiple bits per pixel (i.e., true grayscale or color) will require increased processing power and memory bandwidth. Networked printers require new, faster I/O interfaces as well. HP's dominant market share allows it to set standards in these new areas, but if Destiny can continue to meet these challenges, its customers will steal more of HP's share. ♦

Price and Availability

The 8905 "All-in-One" chip uses a 208-pin QFP and is priced at \$20. The D7001 "RIDA" chip uses a 144-pin QFP and is priced at \$32. The D9001L "EET" uses a 28-pin PDIP package and costs \$10. All of these chips are currently in production. All pricing is for quantities of 1000.

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