PowerPC Technology

The Power Behind the Next Generation of Macintosh Systems

*An Overview for Apple
Third-Party Developers*

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Introduction

In the first half of 1994, Apple will introduce the first Apple® Macintosh® computers based on PowerPC reduced instruction-set computing (RISC) microprocessors. Until now, RISC technology has been used primarily in systems designed for raw computational power, such as engineering workstations and commercial database servers. With the increasing capabilities and decreasing prices of RISC processors, Apple believes that now is the time to bring RISC technology to personal computing. To this end, we have formed an alliance with IBM and Motorola to design and build the PowerPC family of RISC microprocessors. PowerPC technology will create the foundation for a new generation of faster, more powerful Macintosh software. This will allow you to add more value to your existing applications, strengthening your position with current customers. And it will let you develop original programs that extend the capabilities of personal computing, enabling you to open new markets for your products.

Two key factors in the success of this new platform will be the compatibility of existing 680x0 applications and Macintosh peripherals, and the availability of native applications that take full advantage of the PowerPC processor. Apple is designing our new RISC-based Macintosh models to support both of these goals.

First and foremost, these computers will be Macintosh systems:

•They will use the Macintosh System 7 operating system, so they will have the same user interface as today's Macintosh systems and will require no retraining. We are not forcing our customers to change operating systems to enjoy the benefits of RISC performance.

•They will run thousands of Macintosh applications available today—plus upgraded versions and entirely new applications developed specifically for Macintosh systems using the PowerPC microprocessor. Leading software developers including Adobe, Aldus, Claris, Microsoft, Quark, and WordPerfect have already announced their intention to offer upgrades to their existing Macintosh applications.

•They will support nearly all current Macintosh printers, networking cards, and other hardware accessories.

•And they will co-exist with today's Macintosh models, including sharing data and coexisting on a network.

Apple is committed to moving the entire Macintosh family to PowerPC processors. We will first incorporate the technology into midrange and high-end models. Subsequently, we will offer PowerPC processor–based versions of all our Macintosh product lines, from Macintosh Quadra™ and Macintosh Centris™ systems to Performa™, Classic®, LC, and PowerBook™ systems.

Combining the renowned Macintosh user interface with PowerPC processors is another example of Apple leveraging our unique talents to bring an innovative technology to a wider market. As always, we are working with the Macintosh developer community to transform this exciting technology into new business opportunities for you and into powerful solutions for our mutual customers.

Macintosh on PowerPC: Key Points

Developers and customers should keep three points in mind about a PowerPC processor–based Macintosh system:

- It's a Macintosh
- It's compatible
- It offers tremendous performance

It's a Macintosh

PowerPC technology will extend the Macintosh platform in exciting new directions. But it's important to remember that a PowerPC processor–based Macintosh computer will still be a Macintosh.

Although Apple is not the only manufacturer incorporating PowerPC technology into personal computers, we are the only one who can combine this powerful new hardware with the superior user environment of System 7, the Macintosh operating system. Unlike vendors who are requiring users to switch to a new operating system to benefit from RISC technology, Apple is moving our mainstream operating system to PowerPC technology.

Apple's PowerPC–based models will look, act, and feel like Macintosh systems from both a user's and a developer's perspective. For users, the new systems will have an identical user interface and require no retraining. Users will interact with the computer the same way they do today, whether they're copying a file or launching an application.

Customers will be able to mix RISC-based and 680x0-based Macintosh systems on their networks, exchange files and disks between them, and enjoy all the other benefits they'd expect from a Macintosh.

For developers, the Macintosh APIs will continue to be supported on the new systems, allowing you to maintain a single source code base for your application. A PowerPC processor–based Macintosh will simply be a Macintosh that has evolved to a new generation of hardware.

> *"Claris' vision of the next generation of 'smarter' software involves features requiring great amounts of CPU power. Ultimately, Macintosh on PowerPC could make possible a new generation of software which marries incredible power with unique usability."*
>
> *—Daniel L. Eilers*

President and CEO
Claris Corporation

It's Compatible

One of Apple's primary goals in the transition to PowerPC technology is compatibility with existing Macintosh products. Our careful integration of Macintosh system software and hardware allows us to protect your investment in Macintosh systems and your customers' investments in your products.

Compatibility is not limited just to applications. INITs, CDEVs, drivers, and other utility software will also work on PowerPC processor–based Macintosh systems. So will NuBus™ cards (such as networking and video cards), AppleTalk® devices (such as printers), SCSI devices (such as hard disks and scanners), ADB devices (such as mice, trackballs, and keyboards), and other Macintosh cards and peripherals.

"Microsoft has always been a leader in working with Apple technology, and we are excited about the opportunities provided by the PowerPC. We intend to have early support for this platform; Microsoft Excel, Word, and Works will be among the first applications available for the PowerPC."
—Kirk Mosher
Product Manager, Macintosh Line
Microsoft Corporation

It Offers Tremendous Performance

PowerPC processor–based Macintosh systems will offer two to four times the performance of today's fastest 68040- and 80486-based personal computers.

Because of this greater speed, applications written specifically for PowerPC processors will run noticeably faster. In Apple's benchmark testing we have found some cases, such as mathematical calculations, where these systems ran 8 to 10 times faster than today's 68040 and 80486 systems.

Furthermore, as a Macintosh developer, you can use this enhanced power to increase the scope of what is possible with personal computers. We expect that developers will use the PowerPC technology platform to design more intelligent software; make greater use of animation and video; develop new communication services; and make improvements in such technologies as speech recognition, text-to-speech conversion, and voice and language processing.

"Macintosh on PowerPC will provide a low-cost but high-performance system to fill the needs of our professional graphics

customers who are demanding more power and flexibility from

their desktop systems."
—Jerry Barber
Chief Technology Officer
Aldus Corporation

The Customer Transition: 68K to PowerPC

The transition to PowerPC processor–based Macintosh systems will be nearly transparent to users. They can continue to buy whatever hardware and software they need today with confidence that they'll be able to use it with the new systems. What they will notice will be more choices of Macintosh models and application programs.

Hardware Transition

By mid-1994, when customers purchase a midrange or high-end Macintosh system, they'll be able to choose between PowerPC processor–based and 680x0-based models, selecting the one that best meets their needs. Both platforms will coexist for some time.

Apple has announced that our goal is to ship one million PowerPC processor–based Macintosh computers in 1994. Pieter Hartsook, an industry analyst, forecasts that by 1995, more than 80 percent of Macintosh shipments will use the PowerPC processor platform (see Figure 1).

Figure 1. Worldwide Macintosh Shipments by Processor, 1993-1995
Source: *The Hartsook Letter*
© 1993 *The Hartsook Letter. Reprinted with permission*
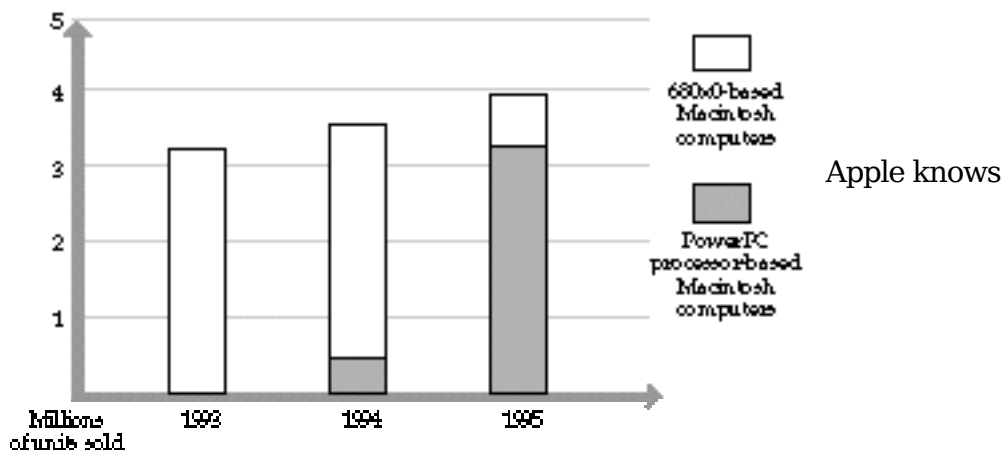
Apple knows that many of our customers will want to upgrade their existing Macintosh systems to take advantage of PowerPC performance. Therefore, we have taken the unusual step of announcing future upgrades to PowerPC technology even before the first PowerPC processor–based Macintosh systems are released.

In May 1993, we announced our intention to offer PowerPC technology upgrades for Macintosh IIvx and IIvi, Macintosh Centris 610 and 650, Performa 600, and Macintosh Quadra 800 systems. In addition, we intend to offer upgrades for the Macintosh Quadra 840AV, the Macintosh Centris 660AV, and the Apple Workgroup Server 80 and 95. Apple and third-party developers are working to create upgrades for other Macintosh models as well. Details on upgrade options will be made available when specific PowerPC processor–based Macintosh products are announced.

Software Transition
Through your efforts, customers will be able to purchase versions of their favorite applications that have been upgraded to take full advantage of PowerPC processor performance, as well as entirely new programs made feasible by this powerful technology.

Apple's research shows that customers are eager for the capabilities of PowerPC processors and for applications that can take advantage of those capabilities. Therefore, we strongly encourage third-party Macintosh developers to begin planning the transition of your products to native PowerPC code right away. See "Three Paths to PowerPC" later in this paper for a thorough description of your transition options.

The Developer Transition: 68K to PowerPC

As Macintosh customers begin making the transition to PowerPC processor–based systems, Macintosh developers will begin a corresponding transition. Apple's primary objectives in this developer transition are twofold.

First, we want to ensure that your existing, unmodified 680x0-based products are compatible with the new systems. This will be achieved through a highly advanced emulator that will be included in the system ROM of all PowerPC processor–based Macintosh computers.

Second, we want to make it as easy as possible for you to develop native applications for the new platform and bring them to market as quickly as possible.

Compatibility for Today's Products

Today's Macintosh applications should run, without modification, on PowerPC processor–based Macintosh models. We expect their performance to be surprisingly responsive. Of course, performance will vary dramatically based on the application and other factors. For example, applications that rely heavily on Toolbox routines will run at higher speeds than those that don't. In actual use, performance will range from a fast 68030- to a 68040-based Macintosh.

We will also continue to support the current Macintosh APIs. Combined with application compatibility, this feature will allow you to maintain a single source code base, and protect your customers' existing data.

To underscore Apple's commitment to compatibility, we invited developers attending the Apple Worldwide Developers Conference in May 1993 to try their current applications on early prototype systems. More than 90 percent of some 600 third-party products ran without any problems. Apple continues to offer such testing worldwide at our own compatibility labs and at industry events.

"We believe the new Macintosh on PowerPC platform will help

meet the performance demands of the professional design

market, as well as offer a lower-cost solution to our customers."
—Dave Pratt
Senior VP and General Manager
Adobe Systems Incorporated

New Opportunities with Native Applications
The real benefits of PowerPC technology will become evident in applications that take direct advantage of the processor's RISC performance. Simply by recompiling your current applications, you can gain full access to this power.

Apple expects the performance of recompiled applications to be two to four times as fast as the same programs running on today's Motorola 68040 and Intel 80486 systems. Applications that use floating-point mathematical operations (3-D rendering and CAD, for example) could see performance increases as high as tenfold.

Users will be able to run both 680x0 and PowerPC applications on the same PowerPC processor–based Macintosh system simultaneously, without switching to any emulation mode or making any changes whatsoever to their normal operations.

A number of leading software developers have already announced their intention to offer new versions of their applications for PowerPC processor–based Macintosh systems. These publishers include Adobe Systems Inc., ACIUS Inc., Aldus Corporation, Claris Corporation, Deneba Software, Frame Technology, Insignia Solutions Inc., Microsoft Corporation, Quark Inc., Specular International, and WordPerfect Corporation.

The wide range of products offered by these prominent companies includes general productivity applications such as word processors and spreadsheets; graphics programs, including rendering and animation; desktop publishing products for page layout and design; and several other categories.

Apple is working closely with these and hundreds of other key developers worldwide to ensure the availability of a wide range of leading applications and to help catalyze entirely new categories of products enabled by the powerful new PowerPC architecture.

"SoftPC will complement the new capabilities of Macintosh on

PowerPC with the ability to run Windows and MS-DOS software,

and the speed of PowerPC will add real zip to our performance."
—Frank Cohen
Director of Marketing
Insignia Solutions

Portability for the Future

By writing (or rewriting) your applications for the PowerPC processor–based Macintosh platform, you'll be doing much of the work needed to move them to other platforms in the future, positioning you well to take advantage of Apple's future cross-platform efforts. You'll also be able to more quickly and easily take advantage of new Macintosh technologies
as they become available.

As you upgrade your 680x0 applications—or create original programs—to run on PowerPC processor–based Macintosh systems, you'll want to follow these guidelines:

•Write in C or C++ (using an ANSI-compliant version).

•Minimize and isolate the use of assembly-language code.

•Make as few assumptions as possible about the hardware architecture and run-time model of the execution platform.

"The PowerPC represents the future of Macintosh computing.

We intend to maintain our leadership position in the Macintosh

development tools market by working closely with Apple and

building a world-class environment for PowerPC application

development."
—Gene Wang
Executive Vice President
Applications and Development Tools
Symantec Corporation

Hardware Overview

PowerPC microprocessors are a new family of processors built on RISC technology. They are being developed as part of an alliance among Apple, IBM, and Motorola.

Why RISC?
As you are probably aware, RISC processors streamline the internal workings of computers. Whereas traditional (complex instruction-set computing, or CISC) processors contain a wide variety of instructions to handle many different tasks, RISC processors contain only those instructions that are used most often. When a complex instruction is needed, a RISC processor builds it from a combination of basic instructions.

RISC processors are designed to execute these basic instructions extremely quickly. The performance gains achieved by speeding up the most-used instructions more than compensate for the time spent creating less-used instructions.

To date, RISC technology has been used only in systems designed for raw computational power. For example, most engineering workstations and commercial database servers use RISC processors. These computers have generally been based on the UNIX® operating system and have therefore been more difficult to install, learn, use, and maintain than personal computer users have come to expect.

Apple believes that now is the time to bring RISC technology to personal computing. One important reason is that the performance improvement of successive CISC processors is leveling off, whereas RISC performance is continuing to grow (see Figure 2). At the same time, RISC will be manufactured in high enough volumes to make it cost-effective for the personal computer market.

Apple is the only personal computer vendor publicly committed to moving its entire product line to RISC technology. This strategy will eventually bring the benefits of RISC to all Apple customers, whether they are buying entry-level, high-end, or notebook systems.

Figure 2. CISC vs. RISC Performance Evolution
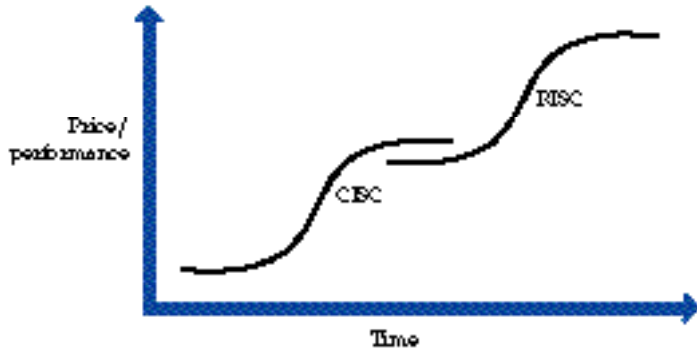
Why PowerPC?
When Apple began to look for the microprocessor that could take Macintosh systems into the next decade, we established a number of criteria. After reviewing most of the leading CISC and RISC architectures in the industry, Apple chose PowerPC technology.

The PowerPC processor project brings:

• *A mainstream standard backed by major vendors*. With the adoption and anticipated sales of Apple, IBM, Motorola, and other leading companies, PowerPC processors should quickly become the largest-volume RISC processors in the world and a serious alternative to the Intel 80x86 standard.

• *A scalable architecture that can be used in all Macintosh systems*. Historically, RISC microprocessors have been optimized for high-end workstations and server systems. IBM's willingness to redefine its POWER RISC architecture to create PowerPC processors has resulted in the first mainstream RISC microprocessor that can be used in low-cost computers. Several versions of PowerPC processors are already being developed to meet the needs of different types of personal computer users. This will give Apple a RISC-based growth path for all Macintosh product lines well into the future.

• *Industry-leading technology*. The involvement of IBM and Motorola brings state-of-the-art expertise in both microprocessor design and manufacturing to the PowerPC processor effort.

• *Parallel designs*. Apple, IBM, and Motorola have combined their considerable resources to develop several versions of the PowerPC architecture simultaneously. This will allow the alliance to bring PowerPC technology rapidly to all segments of the personal computing market. Different PowerPC processors are being designed for the performance, cost, and power-consumption requirements of everything from notebook computers to high-end workstations.

• *Proven high-volume production*. RISC processors today are principally used by lower-volume workstation vendors. Motorola and IBM have proven their ability to manufacture the millions of semiconductors needed for the personal computer market.

• *Superior development tools*. Any new microprocessor architecture needs excellent compilers, debuggers, and other development tools to be successful. Because PowerPC processors are derived from the POWER architecture already used in IBM's RS/6000 workstations, many compatible development products already exist and are being optimized for PowerPC.

Others are being created expressly for the PowerPC processor–based Macintosh platform.

In short, the alliance of Apple, IBM, and Motorola is producing not just a new RISC architecture, but a new level of performance for personal computers.

The PowerPC Microprocessor Family

Apple, IBM, and Motorola are working on four versions of the PowerPC microprocessor simultaneously (see Figure 3). Each version is designed to meet the needs of a different segment of the marketplace.

Figure 3. Processor Availability
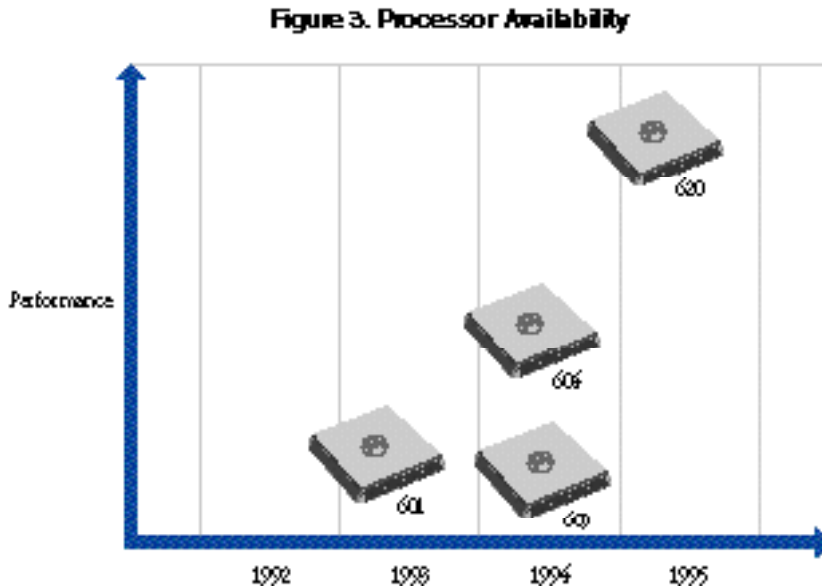
The first microprocessor in the family is the PowerPC 601. The 601 will be in production in early 1994 and will be used in the initial midrange and high-end Macintosh systems.

The PowerPC 603 microprocessor will offer performance similar to the 601 in an even lower-power, lower-cost design. These features will allow Apple to use the 603 in high-volume desktop Macintosh computers and PowerBook models.

The PowerPC 604 microprocessor will eventually replace the 601, allowing Apple to offer even better performance in midrange and high-end Macintosh computers.

The PowerPC 620 microprocessor will be a high-end product offering premium performance and a full 64-bit architecture. It is being designed primarily for high-performance workstations and servers.

PowerPC vs. Pentium
Intel Corporation has recently released a new CISC microprocessor called
Pentium that is being used in some vendors' computers. Intel maintains that
RISC technology is not necessary to provide the power required for
tomorrow's desktop applications.

However, information gathered by Motorola shows that even the first-
generation PowerPC 601 microprocessor has performance comparable to
Pentium in integer calculations and exceeding Pentium in the floating-point
calculations (see Figure 4). Floating-point calculations are needed for
sophisticated graphics, communications, and video applications.

Figure 4. PowerPC vs. Pentium Performance

	Intel Pentium	PowerPC 601
Frequency (MHz)	66	66
SPEC int92	64.5	>60
SPEC fp92	56.9	>60
Power (worst case)	16w	8.5w
Die size (mm²)	262	120

Spec comparisons are based upon prior reports of performance of the 66MHz version of the Pentium as announced by Intel, and Motorola's announced simulation performance of the 66MHz version of the MPC601. Thermal comparison is based upon preliminary Intel specification for the 66MHz Pentium and the performance of samples of the 66MHz version of the MPC601.

Not only does PowerPC outperform Pentium, but it does so in a smaller and
cooler package. Size affects a microprocessor's cost (smaller ones cost less),
while heat output affects which models it can be used in (hotter processors
need more space and electrical power, which precludes their use in notebook
computers).

The size, heat output, and cost of the PowerPC 601 microprocessor are
about half those of the Pentium. All of these factors—combined with its
performance—make the PowerPC 601 a less expensive yet more versatile
foundation for the next generation of personal computers.

Why PowerPC Processors for Macintosh?

When considering the benefits of faster personal computers, many customers think only of faster spreadsheet calculation or graphics drawing.

Indeed, productivity and graphics applications will run much faster on Macintosh systems that use PowerPC processors than on today's Motorola 680x0-based or Intel 80486-based personal computers. But the real promise of PowerPC technology is that it will enable you to deliver new software capabilities on Macintosh systems that are currently available only on high-end workstations.

For example, PowerPC technology will permit Macintosh systems to be more closely integrated with telephone systems for modem, fax, and voice communications. It will help maintain the leadership of Macintosh as the premier desktop video platform: The higher performance provided by PowerPC processors will enhance the capabilities of Apple's QuickTime™ software and enable more sophisticated video processing.

In addition, PowerPC technology will help Apple further improve the Macintosh user experience. Apple is always striving to make Macintosh systems easier to use; by leveraging the computing power of PowerPC processors, we can enrich the Macintosh interface for years to come.

In short, PowerPC technology will provide a powerful, versatile foundation for Macintosh systems for the next decade.

"Apple's new technology will provide an excellent platform for us to build tools that will help our users process, share, and present information across multiple platforms."
—Dave Moon
Senior Vice President of Development
WordPerfect Corporation

The Apple, IBM, and Motorola Alliance
In 1991, Apple, IBM, and Motorola announced that they would cooperate on several vital aspects of personal computer evolution. The alliance agreements cover five major areas, each of which involves independent projects that can contribute to each other.

•*PowerPC*. As is described at length in this white paper, Apple, IBM, and Motorola are working together to develop this new family of RISC microprocessors. The three companies have created the Somerset Design Center in Austin, Texas, where some 300 engineers are designing PowerPC processors. The combined investment by the three firms totals over $1 billion, demonstrating our joint commitment to the success of the PowerPC processor family.

•*Interoperability*. IBM and Apple agreed to make Macintosh computers work smoothly with IBM's enterprisewide systems. This joint effort has already produced a number of networking and communication products, such as the IBM-certified Apple Token Ring card. Work in this area continues and will ensure that Macintosh computers are compatible clients for IBM enterprise systems.

•*PowerOpen*. Customers who need to support UNIX applications and services will be able to use the PowerOpen operating system on selected PowerPC processor–based Macintosh systems.
        PowerOpen, which is being developed by Apple and IBM, is a major new open-systems platform. It will support the simultaneous execution of applications that are compatible with the System 7, Apple A/UX®, and IBM AIX operating systems. PowerOpen represents an excellent incremental business opportunity for developers because any System 7 applications you write can also be used on Macintosh systems running PowerOpen.

•*Kaleida*. Kaleida Labs is a new company funded by Apple and IBM. Its goal is to create standards for multimedia products.

•*Taligent*. This new company, also funded by Apple and IBM, is creating a completely new object-oriented operating system. Due in the middle of this decade, Taligent software will run on Apple's RISC-based systems.

System Software Overview

Apple's system software strategy for the initial Macintosh systems based on PowerPC technology has two key elements:

•Emulator software to retain compatibility with applications written for 680x0-based Macintosh models

•Optimization of System 7 to take full advantage of PowerPC technology

Macintosh on PowerPC Software Architecture
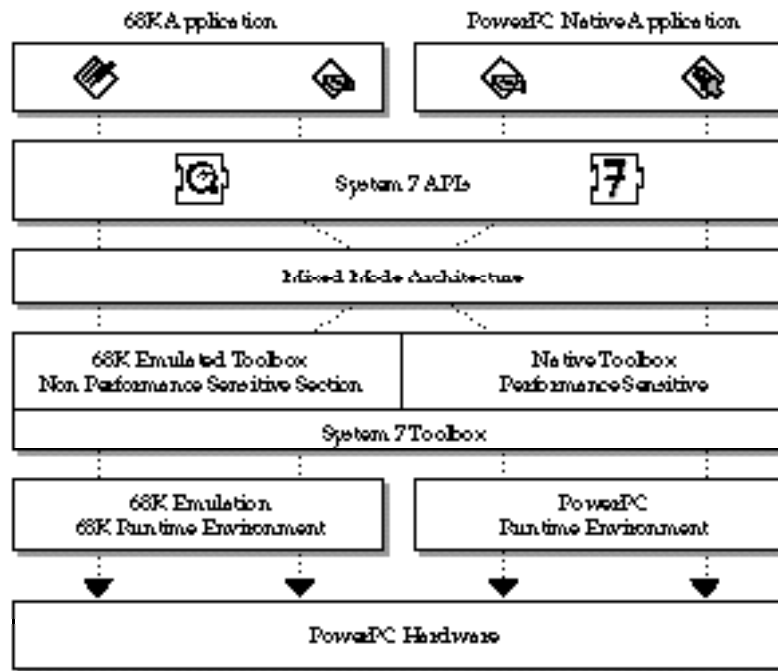
680x0 Emulator
Apple has used its expertise in integrating Macintosh hardware and software to write an emulator for the LC68040 processor (a 68040 with no floating-point unit). This emulator is extremely reliable, so your existing Macintosh applications should run fine on the new machines. And because of the high speed of the PowerPC processor, the emulator provides excellent performance.

The emulator will be part of the ROMs shipped with all PowerPC processor–based Macintosh systems. An accompanying Mixed Mode Manager transparently handles context switches so that applications developed for both the 680x0 and PowerPC processor environments can run simultaneously on the same machine.

The emulator protects your customer base by allowing Macintosh users to run current versions of your programs on their new systems while you are upgrading your products to take advantage of native PowerPC processor capabilities.

System 7 Optimization

The primary operating system for PowerPC processor–based Macintosh computers will be System 7. This is the same user environment that ships today with all Macintosh systems.

Apple is optimizing parts of System 7 for the highest performance on the PowerPC processor. This optimization will benefit applications written for 680x0 systems as well as those developed specifically for PowerPC processor–based systems. It will not affect the System 7 user interface.

Apple is modifying the Macintosh Toolbox procedures that take the most computational power (such as QuickDraw™ routines) to take full advantage of the RISC performance of PowerPC processors. Over time, more and more of the Macintosh operating system will be converted to native PowerPC code. This means that RISC–based Macintosh systems will actually get faster as Apple releases new system software.

"Macintosh on PowerPC is an ideal platform for FrameMaker

users because the power and performance of PowerPC maps so

well with FrameMaker's advanced document publishing

capabilities."
—Martin Doettling
Macintosh Product Line Manager
Frame Technology

Three Paths to PowerPC

As a Macintosh software developer, you have three options—emulation, translation, and porting—for migrating your applications to Macintosh systems based on PowerPC processors (see Figure 5). This section discusses those options and describes the Apple and third-party development tools you can use for each.

Figure 5. Three Developer Paths to Macintosh on PowerPC
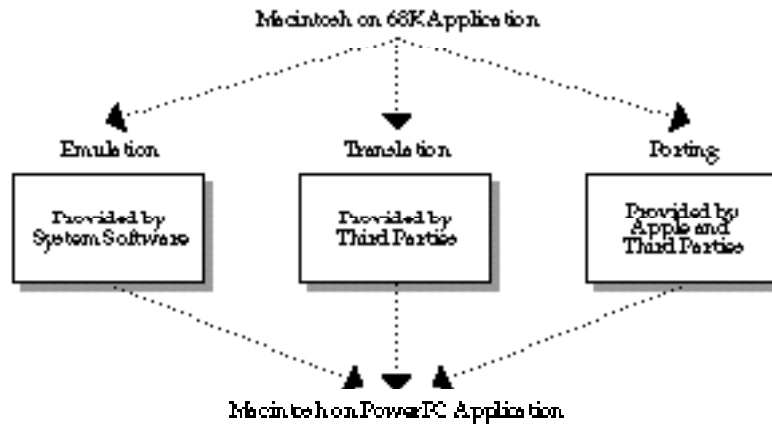
Emulation: No Modification Required

Existing 680x0 applications will be able to run on PowerPC processor–based Macintosh systems without modification via the LC68040 emulator. We expect the performance of these unmodified applications to be highly responsive.

As stated earlier, third-party developers have already tried some 600 current Macintosh applications on early prototype PowerPC processor–based systems, and more than 90 percent of those products ran without any compatibility problems.

"The new Macintosh represents a quantum leap in processing

power and our new compiler architecture was designed

specifically for RISC processors and advanced architectures such

as this incredible machine."

—Greg Galanos
President and CEO
Metrowerks, Inc.

Translation: Native Performance
The second developer path to PowerPC technology is translation. This option falls between emulation and porting on the migration continuum, offering native performance significantly exceeding that available through emulation, but often less flexibility than porting.

Developers selecting this path can choose from among several third-party tools to translate 680x0-based Macintosh applications into native PowerPC applications:

•Assembly-language translators convert source code between the respective assembly languages of 680x0 and PowerPC processors. The resulting file is then run through an assembler for the target processor.

•Binary translators semi-automatically convert a 680x0 Macintosh application (without source code) to a version that will execute on PowerPC processor–based Macintosh systems.

•High-level translators convert source code from one programming language to another.

Announced third-party translation tools for Macintosh on PowerPC technology include:

•PortAsm from MicroAPL, an assembly-language translator

•FlashPort from Echo Logic, a binary translator

•p2c from Sierra Software Innovations, which translates Pascal and Object Pascal to C and C++

Porting: Native Performance Plus New Features
The third developer path to PowerPC technology is porting. Ported applications can enjoy all the benefits of PowerPC processors: They'll experience higher performance for existing tasks, and can be modified to take advantage of the new features that this technology makes possible.

Both Apple and third-party developers plan to provide tools for recompiling existing 680x0-based Macintosh applications to execute directly on PowerPC processor–based systems, as well as for creating new applications specifically targeted for this platform.

By providing its own tools and supporting the efforts of third-parties, Apple intends to ensure that all applications developers will be able to create native applications that tap the power and performance of the new PowerPC processor–based Macintosh computers. Nine leading third-party tools vendors have already announced support for Macintosh on PowerPC: Absoft Corp., Bowers Development Corp., Echo Logic, Language Systems Corp., Metrowerks, Inc., MicroAPL, Sierra Software Innovations, Symantec Corp., and TGS Systems. Collectively, the PowerPC tools provided by Apple and these vendors will support a range of programming languages and development tools, including compilers, debuggers, translation tools, interface building tools, and more.

The first porting tools offered by Apple will run on 680x0-based Macintosh systems. Later, a native development environment will be available for PowerPC processor–based Macintosh systems.

> *"PowerPC represents a major revolution in desktop computing*
>
> *price/ performance that will enable developers to create*
>
> *applications we can't imagine today. Our upcoming PowerPC*
>
> *development environment and class libraries will redefine how*
>
> *these next-generation applications are created in the '90s."*
>   —Ralph Barhydt
>   President and CEO
>   TGS Systems

The Macintosh on RISC SDK

Apple will offer a software developers' kit (SDK) as a transitional development environment that will enable early adopters to bring applications to market at or near the time we introduce our first RISC-based Macintosh models.

Using the Macintosh on RISC SDK, you'll be able to develop native PowerPC applications using a 680x0-based Macintosh computer. Editing, compiling, and linking will be performed on a 680x0-based Macintosh; execution and debugging on the target system. The familiar MPW$^®$ (Macintosh Programmer's Workshop) development environment running under System 7 will be the foundation of this cross-development environment.

The Macintosh on RISC SDK will include the following:

•C and C++ cross compiler for the Macintosh on PowerPC

•PowerPC cross assembler

•PowerPC cross linker

•MacApp® for the Macintosh on PowerPC

•A remote source-level and machine-level debugger for the Macintosh on PowerPC

•Interface files and libraries for the Macintosh on PowerPC

•Tools and documentation to ease the transition to an MPW based development environment for users of Symantec's Think C

•Additional tools to assist in porting 680x0-based Macintosh applications to the PowerPC processor–based Macintosh

•Sample code illustrating how to port a 680x0-based Macintosh application to the Macintosh on PowerPC platform

•Electronic documentation

Phased delivery of porting tools
Wide availability of the Macintosh on RISC SDK is planned for the third phase of Apple's strategy for delivering porting tools for the Macintosh on PowerPC platform. The phases are as follows (see Figure 6):

Figure 6. Four Phase Porting Tools Timeline
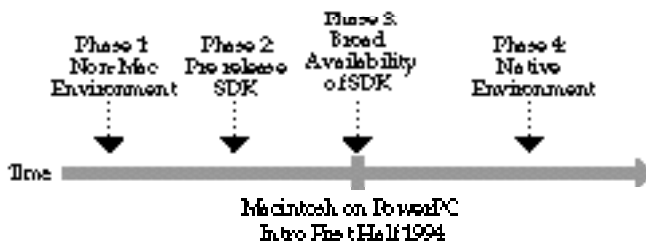
Phase 1: Highly limited, non Macintosh hosted environment.

The first phase began in early 1993 and involves a very small number of software vendors who are working closely with Apple to port their applications to PowerPC processor–based Macintosh systems using a cross-development environment hosted on an IBM RS/6000 workstation. The RS/6000-based environment was created expressly for this early development program and is no longer available.

Phase 2: Limited-access prerelease development environment. The second phase
of application porting will involve several hundred Macintosh developers worldwide. They'll use the cross-development environment provided by the prerelease version of the Macintosh on RISC SDK to port their applications to preproduction PowerPC processor–based Macintosh systems.

Taking place before the first release of Apple's new systems, this second phase of porting will include early adopters who wish to bring their applications to the RISC–based Macintosh at or near the time of introduction.

Phase 3: Broad availability of Macintosh on PowerPC development environment.
The third phase of tools delivery—wide availability of the Macintosh on RISC SDK—will follow the introduction and customer shipment of PowerPC processor–based Macintosh computers, scheduled for the first half of 1994. The Macintosh on RISC SDK will be made available to developers worldwide. Pricing and availability will be announced later.

Phase 4: Native development environment. In addition to providing a transitional SDK, Apple is working aggressively with Symantec Corporation on a native development environment for the Macintosh on PowerPC platform.

This product will be available after Apple begins customer shipments of PowerPC processor–based Macintosh systems. It will provide powerful, flexible, easy-to-use development tools, and will let you use a PowerPC processor–based Macintosh system for the entire development process, from editing to debugging.

Getting Started

Apple expects to ship the first PowerPC processor–based Macintosh systems in the first half of 1994. You can do many things today to get ready for your migration to this new platform.

If you're a developer with an innovative idea for exploiting the power of PowerPC technology in a Macintosh application, send an AppleLink® message to POWERPC.DEVS and you'll be considered for PowerPC evangelism programs. All general developer inquiries should be directed to AppleLink: DEVSUPPORT.

Preparing for PowerPC: The Ten Commandments
Following these ten "commandments" will ensure as smooth and fast a transition to Macintosh on PowerPC as possible:

1. Write in ANSI C or C++.
2. Ensure that data structures are aligned.
3. Don't depend on the 680x0 run-time model.
4. Isolate and minimize use of low-memory globals.
5. Isolate and eliminate use of internal Toolbox calls.
6. Isolate dependencies on 80-bit extended format numeric type.
7. Don't depend on specific interrupt levels.
8. Be 32-bit clean. This is mandatory!
9. Avoid patching traps.
10. Do the right thing!

Sources for Further Information
For more information on Macintosh on PowerPC, look to:

•"The PowerPC in Your Future, " *Apple Direct*, July 1992.

•"PowerPC Development Update," *Apple Direct*, March 1993.

•"Macintosh on PowerPC: Top Developer Q&As," *Apple Directions* (formerly *Apple Direct*), June 1993.

•"Making the Transition to PowerPC," *Apple Directions*, August 1993.

•Future issues of *Apple Directions.*

•The Macintosh on PowerPC folder on AppleLink (path: Developer Support: Developer Services: Macintosh on PowerPC).

•"10+ Commandments," Macintosh Technical Note (M.OV.10+Commandments), June 1993.

•Audio and video tapes from the 1993 Worldwide Developers Conference PowerPC sessions.

•Developer University self-paced PowerPC courses, available through APDA.

A Final Word

Apple is the only personal computer vendor who can combine RISC performance with the renowned Macintosh ease of use, creating an exciting new generation of personal computers. Our integrated approach to hardware and system software design allows us to make a smooth transition to PowerPC technology that will protect compatibility with your current Macintosh products while providing a stable foundation
for you to create powerful, innovative applications and peripherals.
        No other personal computer company is making the fundamental commitment to RISC demonstrated by Apple in moving our entire line of Macintosh systems to PowerPC technology. We look forward to working with third-party Macintosh software and hardware developers to fully exploit the benefits of this innovative personal-computing platform.

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