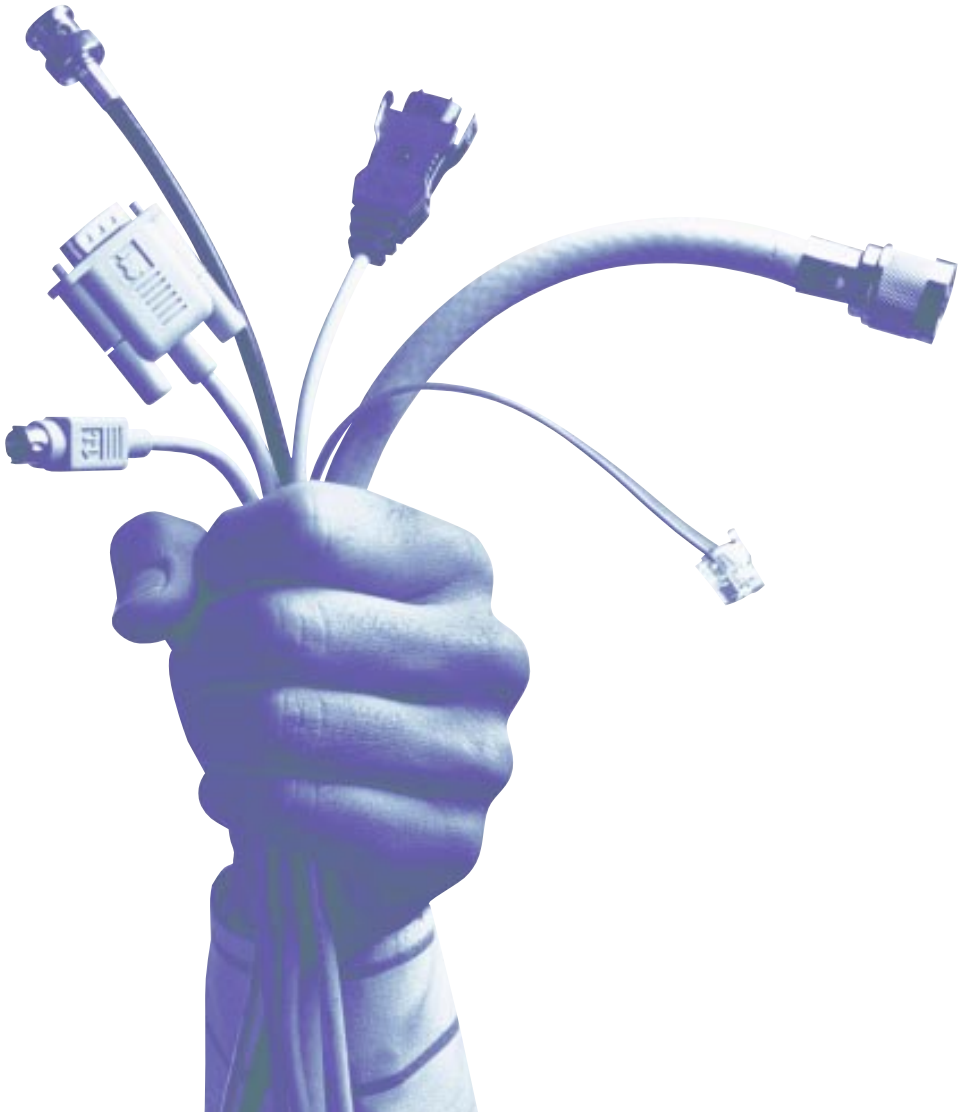
Apple Open Transport

A Mac OS Technology White Paper



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Printed on recycled paper. Printed in the U.S.A. 5/96 L01843A

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Introduction

Today, more individuals and enterprises are making use of networking technology than ever before to increase their productivity and their efficiency. But as the numbers on networks have grown, so have some difficulties that are making the jobs of network designers, managers, and administrators increasingly challenging. End users are also experiencing problems with getting the maximum advantage out of networking technology. And developers of networking applications are often adversely affected by the problems of both groups.

Open Transport is Apple Computer, Inc.'s response to the perceived problems of networking today. It's a modern, standards-based implementation of networking and communications designed to help everyone involved in networking on the Macintosh® system—no matter what type of network is concerned. It supports multiprotocol networking by providing an entire new networking subsystem, including application programming interfaces (APIs), a model for integration with the underlying operating system, and human interface components that provide an all-in-one tool for configuring systems to handle a variety of local area and wide area networking systems (LANs and WANs), as well as serial data communications. The result is easier ways to accomplish tasks, new capabilities, and heightened productivity—for both individual users and entire organizations, and for network managers and network application developers.

This paper discusses the need for such a product; explains the nature of Open Transport; and details the benefits that Open Transport can bring to end users, network managers, and network application developers. It also includes discussion of the impact that Open Transport may have on current network and network-based applications, and concludes with an explanation of Apple's distribution policy for Open Transport and its current availability and level of developer support.

The Need for Open Transport

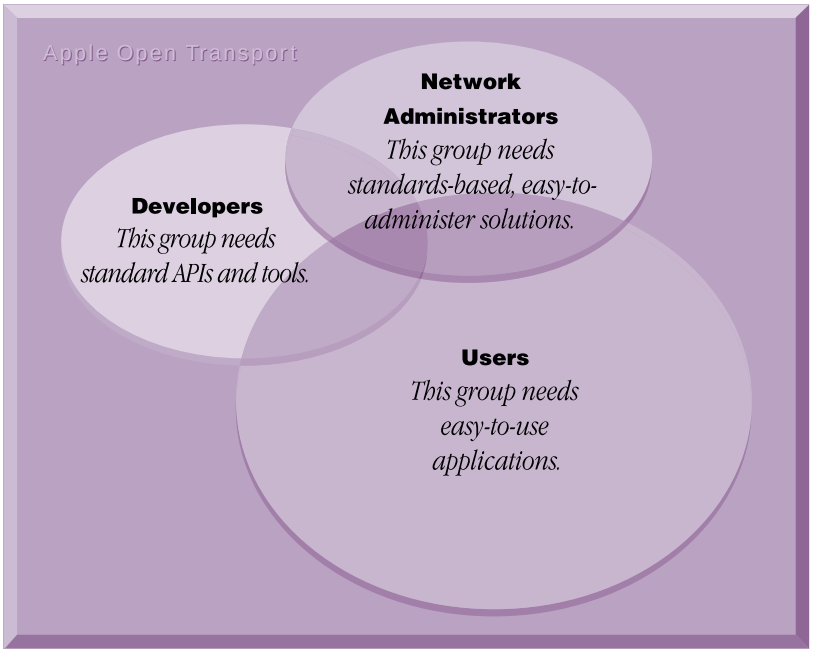
What's wrong with networking today? If you talk with network designers, managers, and administrators, most of them will tell you that their number-one problem—other than a lack of resources—is protocol proliferation. Through inheritance of legacy systems, the rapid expansion of desktop systems in the enterprise, and a move to open system standards like UNIX®, networks have become more and more complex—and, as a result, harder and harder to manage.

The problem is far from merely academic or theoretical in nature; there are significant monetary costs associated with the support of network infrastructure. And there are other costs that are just as real—and perhaps even more significant—costs in productivity through network downtime or lack of interoperability.

At Apple, we believe that the problem is much deeper than this symptom of protocol proliferation. The real problem comes from the fact that networks are designed, optimized, and judged to meet the needs of groups with widely varying needs: end users, network managers, and developers.

- ***End users*** are concerned solely with what they can do using the network, or what the network can do for them. They select applications based on functionality and ease of use, without regard to network infrastructure requirements. Historically, Apple has tightly focused on this group's needs. As a result, AppleTalk®is hailed by the industry as the easiest networking system to set up and use.
- ***Network managers*** are the group most concerned about protocols; it simply costs less to maintain a homogeneous network infrastructure than a heterogeneous one. Because of this, network managers face very real pressures to standardize, to move toward a single protocol backbone. Apple has worked to promote the availability of key standards—TCP/IP, SNA, DECnet, AppleTalk, Point-to-Point Protocol (PPP), X.25, and more—on the Mac™ OS. And, since the introduction of System 7.5, Apple has been focusing more and more on the de facto standard for multiplatform networking—TCP/IP—as the basis for products for the Internet and "intranet" markets.
- ***Developers*** want to create compelling functionality in their applications. They care about network technology, to the extent necessary, in order to appeal to users. They are also influenced by the availability of network infrastructure; they must choose to use specific APIs when writing their applications, which creates a strong binding between the application functionality that the user wants, the APIs selected, and the underlying network infrastructure requirements driven by the API choices.

Clearly, the varying needs of these three groups can often put them at odds. For example, if the user dictates specific applications, it may create unbearable support costs for the network manager. If the network manager dictates protocols, users may not have access to the applications they want and need. And the developer is stuck in the middle, making more or less permanent decisions for both users and network managers by selection of an API at compile time.



Apple® Open Transport: Addressing the Needs of Multiprotocol Networking

At Apple, we believe that finding an answer to this apparent dilemma starts by realizing and accepting the fact that this is a multiprotocol world. By accepting this, we can begin to focus on solutions that adapt to and manage the complexity, rather than pretending that it will go away. But it is also important to take into account current situations, investments, and loyalties; therefore, Apple's answer to the multiprotocol networking dilemma is designed with the following goals in mind:

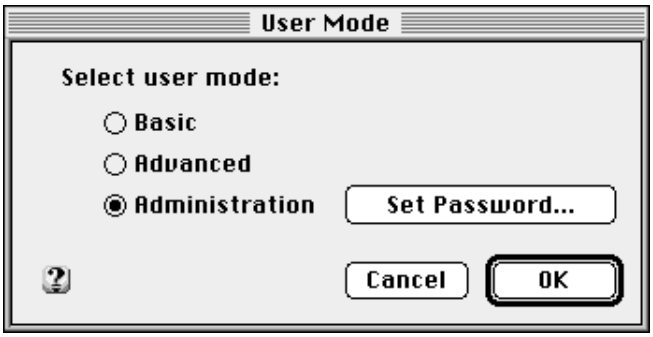
- Protecting customer and developer investments in existing infrastructure
- Using existing cross-platform industry standards
- Shielding both users *and* developers from the underlying complexity
- Providing a very flexible run-time model—one that lets a specific protocol be configured and bound at run time, rather than statically bound at compile time

Characteristics of Apple Open Transport

Open Transport, the innovative networking and communications subsystem for the Mac OS, meets these goals—and more. It consists of new implementations of every aspect of Macintosh networking and communications, including new programming interfaces, a new model for integration with the underlying operating system, and new human interface components. Open Transport is not just for LANs and WANs, but also integrates serial communications and modems as well as remote, or dial-up, networking in a single consistent framework. It runs on 680x0-based Macintosh computers and is accelerated for systems based on PowerPC™ RISC processor technology.

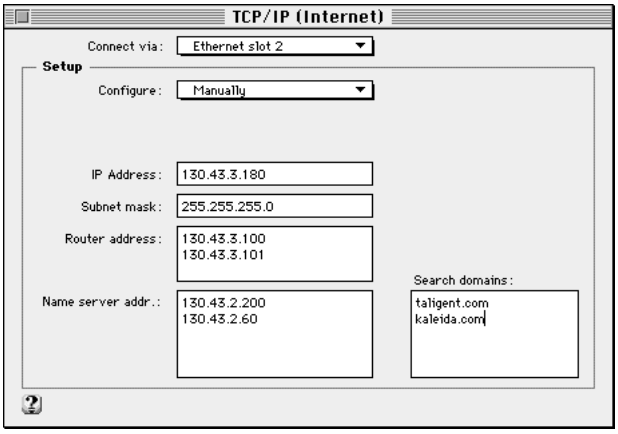
The process of setting up and managing networking configurations with Open Transport is both simple and flexible, because Open Transport offers three levels of control:

- Basic/Novice provides only the most essential information, shielding users from the complexities of networking configuration.
- Advanced/Expert presents all of the available configuration data and choices, offering sophisticated users a high degree of control over their networking configurations.
- Administration provides password-protected control over the entire range of configuration data and choices—along with the option of locking any or all of the items.

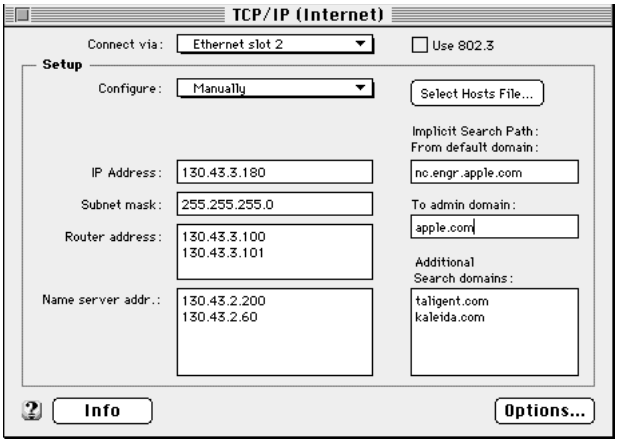


By tightly integrating support for multiprotocol networking with the Mac OS, and by including this capability as a standard part of the operating system, Apple ensures that both users and application developers can come to count on the presence of multiprotocol networking in the Mac OS in the same way as they previously depended on AppleTalk. In fact, with Open Transport, Apple's message to the world has been altered from "Macintosh has built-in AppleTalk networking" to "Macintosh has built-in multiprotocol networking."

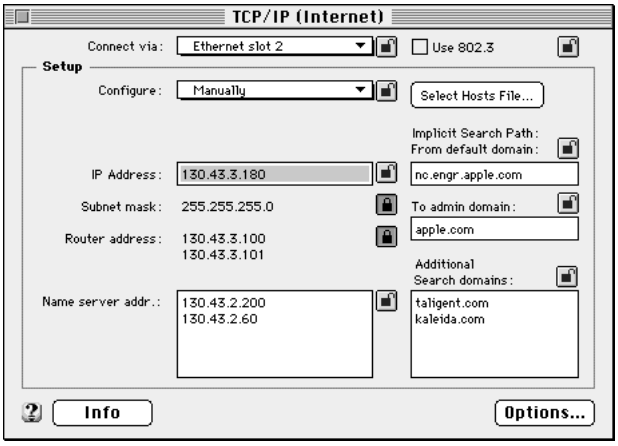
The screen to the right shows the Basic view for configuring TCP/IP. It is designed to show only the most basic information required to enable this service.



The screen to the right shows the Advanced view for configuring TCP/IP. Notice the addition of several 'expert' options including support for a local hosts file and 802.3 framing.



The screen to the right shows the Administrator view for configuring TCP/IP. Notice the addition of 'locks' for each information field. Locked fields can be changed only with the administrator's password.



The Underlying Architecture

Open Transport is built on a foundation of dynamic link-and-load memory management services. This allows networking services to be loaded and unloaded as needed, and provides the foundation for run-time protocol configuration.

On that base, Open Transport brings three key industry networking standards into the Mac OS:

- The X/Open Transport Interface (XTI), the POSIX-compliant API for support of networking applications
- The Datalink Provider Interface (DLPI), for development of network interface controller (NIC) drivers
- A port of a UNIX System V Release 4.2–compatible STREAMS environment for network protocol developers

To maximize the stability, performance, and robustness of Open Transport, Apple selected Mentat Inc.—the leading supplier of high-performance kernel-level network software—to supply the STREAMS environment for Open Transport. Mentat Portable STREAMS (MPS) is a fast, full-featured, multiprocessor-safe version of the UNIX System V Release 4 STREAMS environment. Its incorporation into Open Transport provides a reliable platform for protocol development, and allows easy porting of third-party protocols from other platforms. MPS is the same implementation of STREAMS found inside many industry-standard UNIX operating systems, including those from IBM and OSF, as well as other platforms such as Novell NetWare.

Within the STREAMS environment, Apple supplies implementations of AppleTalk and TCP/IP protocols, and support for LocalTalk®, Ethernet, and Token Ring networks; development of an implementation of PPP is under way. Support for other datalinks—including ATM, FDDI, and Fast Ethernet—is currently available from third-party developers.

To promote cross-platform interoperability and facilitate porting, Apple licensed and implemented the X/Open Transport Interface (XTI) as the key API for Open Transport.

X/Open is an organization dedicated to the establishment of information technology (IT) standards, and is now part of The Open Group, which also incorporates the Open Software Foundation (OSF). Combining the two organizations' individual skills under one umbrella organization, The Open Group is a leading authority in open systems. As such, it is well positioned to assist vendors and users in the development and implementation of products that support the adoption and proliferation of open systems principles.

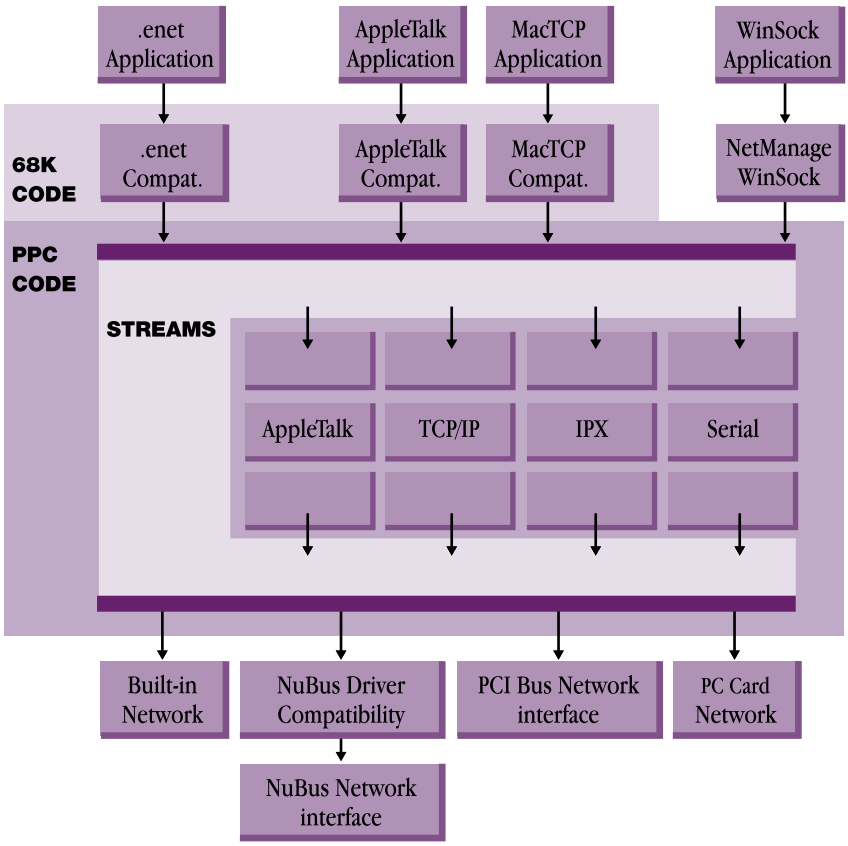
As part of The Open Group, X/Open maintains the responsibility for the agreement of industry standards and related testing, as well as running a product branding program. Now carried by more than 1,500 products, the X/Open brand is recognized by developers and users worldwide as the guarantee of compliance to open systems standards.

X/Open maintains a presence on the World Wide Web at http://xoweb.xopen.org/.

In addition to STREAMS and TCP/IP, Mentat also provides STREAMS-based XTP and XNS protocol stacks. By emphasizing both portability and performance, Mentat delivers highly reliable and maintainable software. Mentat has licensed its software to more than 30 major OEMs throughout North America, Europe, and Japan, including Apple, Hewlett-Packard, IBM, Motorola, Novell, OSF, Sony, Sun, and Xerox.

Mentat Inc. is located on the World Wide Web at http://www.mentat.com/.

Open Transport Architecture



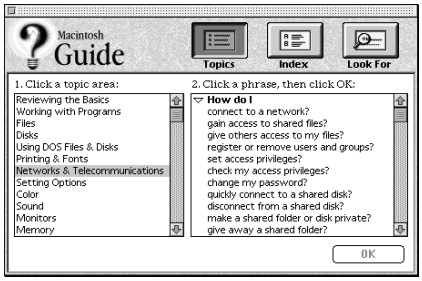
Note: Windows Sockets (WinSock) support is available for Open Transport from NetManage, Inc., a leading TCP/IP tools and applications vendor known for its products and expertise in the Windows environment.

The Benefits of Open Transport

Open Transport offers numerous benefits for all three groups defined earlier: end users, network managers, and developers—without the trade-offs in favor of a particular group that previously characterized networking in a multiprotocol world.

Benefits for End Users

Individual users will find that Apple Open Transport makes it easier to set up and use networking because of the following:



- It features new networking control panels with full support for Apple Guide on-line help (requires System 7.5).
- It lets users set up and save multiple networking configurations easily.
- It allows for switching between networking configurations without a system restart, which can be particularly useful for mobile users.

Benefits for Network Managers

Network managers will enjoy a streamlined day-to-day work process, along with significant new flexibility and capabilities:

- Open Transport provides network managers with the ability to recommend or require configuration settings for users on the network—or to allow users to determine their own settings.
- It improves support for centralized configuration management, for example, by supporting the Dynamic Host Configuration Protocol (DHCP), which allows network managers to administer addressing and other TCP/IP configuration information from a central server.

Benefits for Developers

Developers will discover that Open Transport both speeds and simplifies their efforts in a number of ways, as well as providing them with new capabilities:

- Because XTI, STREAMS, and DLPI are well-known cross-platform industry standards, many developers already have the expertise and tools required to support development for these environments. This means that it's easier and more cost-effective for them to develop Mac OS–based applications for a wide variety of customers and markets, since they no longer have to deal with numerous platform-specific environments.

- Because Open Transport puts all its functionality behind a single, consistent set of APIs, and offers a dynamic link-and-load run-time environment, developers no longer have to choose protocols when choosing an API.
- The fact that the same set of APIs will allow an application to run over multiple protocols, without significant change to the program, both lowers development costs for programs that support multiple protocols and provides developers with access to the broader markets that result from writing to multiple protocols instead of a single protocol.

Benefits for All

Apple's adoption of a fully standards-based architecture for networking is certainly most significant to application developers, but it also has important benefits for individual users, network managers, and organizations. These include the following:

- Because it is easier to port network protocols, drivers, and applications from other platforms (especially UNIX) to the Mac OS, an even wider selection of networking software for the Mac OS becomes available.
- Because a larger developer community is focused on STREAMS than would be focused solely on the Mac OS, the Macintosh community can take advantage of third-party development efforts. For example, Open Transport TCP already supports the emerging Internet standard for carrying video and audio data, IP Multicast. Looking ahead, Apple has already demonstrated IPv6 (next-generation TCP/IP) on the Macintosh platform in cooperation with Mentat Inc.
- Developers experienced in writing high-performance, high-reliability networking hardware and software for UNIX systems can apply their expertise directly to the Mac OS, accelerating the availability of similar solutions for Macintosh systems.

The Overall Benefit of Transport Transparency

Perhaps the most important benefit that Apple Open Transport offers is in providing the foundation for applications to exhibit a characteristic we call "transport transparency."

For users and network managers alike, transport transparency means freedom of choice: freedom to choose the best applications software, freedom to control which protocols are deployed on the network—and the freedom to make these choices independently.

Ultimately, the real value of transport transparency is in a freedom of choice that extends over time; a freedom of choice that allows technology and standards to change and evolve, that allows deployed infrastructure to change and evolve in response—but does not require new applications software.

What constitutes transport transparency? Essentially, three things:

- Users can search, identify, and select network-based resources in a unified and consistent manner, even when the available network resources are spread across a variety of dissimilar directory services. This might include AppleTalk NBP, NetWare NDS, TCP/IP DNS, and even OSI X.500. The principle here is that users shouldn't have to care about the details of the "plumbing" below.

- Developers are insulated from the details of network plumbing. From an application point of view, the conceptual model is very straightforward: Browse, Select, Open, Read, Write, and Close. The details of the Browse and Select are handled by the system, and the Open works directly with the Select so that the application does not have to handle the details.
- Most importantly, hosts offering services to the network must provide a way for administrators to configure the service for a specific protocol or protocols. Changing this characteristic at the server level enables clients to adapt transparently to the new protocol configuration the next time they connect.

Transport transparency is also subject to certain guidelines and good programming practices. All protocols have many features in common, but each also has some unique features. Even with Open Transport, it remains possible to write a transport-specific application. While Apple usually discourages developers from developing transport-specific applications when not necessary, it may be appropriate to develop such an application to access a specific feature or characteristic that is unique to a particular protocol.

Compatibility

As previously stated, a key goal in developing Apple Open Transport was to provide compatibility with existing applications so that customers would experience a smooth migration. Toward that end, Open Transport includes software libraries that provide "backward compatibility" services in four areas:

- Support for existing applications that utilize the documented AppleTalk APIs
- Support for existing applications that utilize the documented MacTCP® APIs
- Support for MacTCP Link Access Extensions (mdevs) on a case-by-case basis
- Support for existing NuBus-based network interface cards and drivers

Apple has defined three levels of interoperability with Open Transport. The first—known as "Open Transport compatible"—is used to describe any network application originally developed for "classic" AppleTalk or MacTCP that now takes advantage of Open Transport Compatibility Services. Such applications automatically gain the benefits associated with the new Open Transport configuration utilities; however, they will not realize a significant performance increase on systems based on PowerPC processor technology, nor can they take advantage of the transport-independent capabilities of Open Transport.

"Open Transport ready" applications are those that have been modified to adopt the new Open Transport APIs (XTI). They are PowerPC native, in addition to running on 680x0-based Mac OS systems; therefore, Open Transport ready applications not only benefit from the new configuration utilities, but also have the opportunity for a significant performance boost when running on PowerPC processor–based systems.

The third category of interoperability is referred to as "Open Transport enhanced." In addition to adopting the new Open Transport APIs and being PowerPC native, these applications have been modified to exploit the transport-independent capabilities of Open Transport.

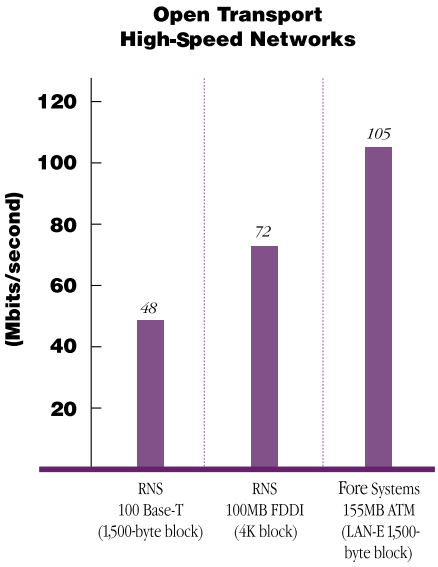
Customers should note that Open Transport is compatible with their existing AppleTalk and TCP/IP networks at the "packets on the wire" level. Organizations can introduce one, a few, or hundreds of new Mac OS–based systems running Open Transport into their environment without worrying about interoperability with existing networking services.

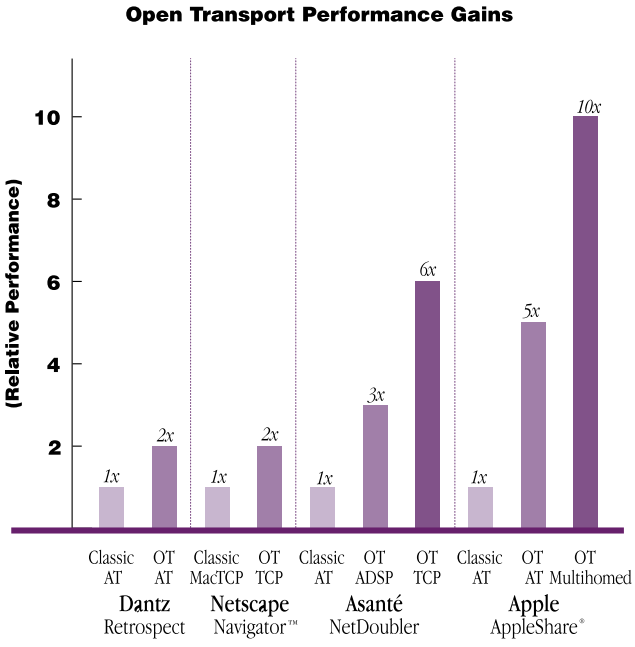
Performance

Open Transport is written to take advantage of the PowerPC processor: It is native code. This provides the necessary foundation for significantly increased networking performance on the Mac OS; but, as mentioned in the previous section, to realize the performance gains at the application level, networking applications must also be accelerated for Power Macintosh® and adopt the new Open Transport XTI programming interfaces.

The compatibility services for existing AppleTalk and TCP/IP applications run as 680x0 code in emulation on Power Macintosh systems. This protects a customer's investment in network applications, but also obscures—or in some cases, outweighs—the underlying performance increases from the native protocol implementations.

Users who select PowerPC-native applications that are Open Transport ready will realize the greatest performance gains. Performance of specific network applications may also be significantly influenced by the underlying processor speed of the system. Customers with demanding, network I/O–intensive applications should give strong consideration to the higher-performance PowerPC Mac OS systems.





AT=AppleTalk
OT=Open Transport

Availability, Distribution, and Developer Adoption

The current version of Open Transport is 1.1. This general release includes a number of updates and new features over earlier releases, as summarized below:

- Support for 680x0 systems as well as PowerPC processor–based systems
- Support for NuBus, SCSI, and CommSlot network interface adapters as well as PCI bus
- Performance tuning to optimize performance of high-speed datalinks and multiple-client, multithreaded server applications
- Support for multinode and multihome operation of AppleTalk protocols
- Support for raw packet access and promiscuous mode, to enable the development of Open Transport ready network analyzers and other network management utilities
- Support for Mac OS System 7.5.3 and its "universal system folder"

Open Transport version 1.1 forms an integral component of Mac OS system software version 7.5.3, as well as the System 7.5 Update 2.0. It is also available as a free upgrade to customers with existing MacTCP and system software volume license software maintenance agreements, as well as through the retail channel as a single-user software package.

Developers who take advantage of Open Transport in their network applications can apply for an extension of the Mac OS software development kit (SDK) license, allowing them to redistribute Open Transport libraries at no additional charge.

Currently, several hundred developers are actively working on Open Transport–related products. These include the following developers:

- Adobe Systems
- AG Group
- Asanté
- Atomic Games
- Attachmate
- CE Software
- Claris Corporation
- Dantz Development
- Digital Equipment Corporation
- Farallon Computing, Inc.
- Fore Systems, Inc.
- 4-Sight International Limited
- Gradient Technologies
- Hughes Advanced Systems
- IBM
- Innosys
- Intercon Systems, Inc.
- Interphase
- Metrowerks, Inc.
- Neon Software
- NetManage, Inc.
- Novell
- Progressive Networks
- RNS (formerly Rockwell)
- SAT/SAGEM
- SoftArc
- Starlight Networks
- StarNine Technologies, Inc.
- Thursby Systems Software, Inc
- White Pines
- Workstation Technologies

Conclusion

Apple Open Transport represents a significant improvement in coping with the problems inherent in a multiprotocol world. It takes advantage of existing standards to simplify the work of everyone from end users to network application developers to network managers, enhancing their efficiency while improving ease of use.

Looking ahead, Apple is actively working to provide support for additional protocols, either through Apple research and development or through alliances with third parties. In addition, as more and more developers write their applications to make optimal use of the capabilities of Open Transport, both end users and network managers should experience even more performance enhancements and improvements in productivity.

Open Transport is also the networking architecture for the next major release of the Mac OS, code named Copland. Under Copland, Open Transport will take full advantage of the microkernel's capabilities, including preemptive scheduling, multithreading, and protected memory. As a result, Open Transport represents both a safe technology investment today and a valuable preview of the future of Mac OS.