

Why NT and When CE

This paper attempts to clarify the differences between Windows NT and Windows CE. Windows NT gives users an open system with an abundance of applications available to them, however, it does lack determinism. Hyperkernel, real-time extensions to NT, provides the stability and determinism required to take Windows NT into today's real-time applications. Windows CE is a truly embedded operating system, not a PC operating system. While it may become real-time in the future, it must prove its stability and reliability. The Hyperkernel Portability Layer (HPL) is a complete "open" solution API that enables NT applications to be recompiled as CE applications. This provides enormous flexibility for application developers, enabling the creation of operating system independent code.

INTRODUCTION

Developers of true deterministic real-time operating system (RTOS) applications have been constrained by limited development tools available only for their proprietary RTOS environment. The introduction of real-time extensions for the Windows NT[®] operating system now allows developers to leverage the benefits of the rich Windows development environment (with thousands of off-the-shelf resources) to create deterministic real-time applications in less time, with less effort, and at a lower cost. At a time when factory automation, process control, and industrial/machine control markets have begun to embrace Windows NT, Windows CE now raises additional questions such as: Where does Windows CE fit into the picture? Can Windows CE be used for machine control? Does Windows CE replace Windows NT? These questions are just a few of those being asked concerning the future of Windows; which one do you choose?

WINDOWS NT

Windows NT is an Open Architecture PC platform operating system, which promotes software competition and prevents a single vendor from being the sole supplier of a solution. This environment allows application developers to create programs, without special tools or hardware, which run on the Windows NT operating system. These programs can send and receive data and communicate seamlessly with applications developed by other developers. Since Windows NT is not a proprietary system, users can leverage the development tools, communications protocols, hardware peripherals, and connectivity tools that are widely available and relatively inexpensive. An open system provides ready access to many applications. However, the negative side of an open system is the lack of control that users have over the system. Windows NT provides the mechanisms for anyone to write applications and redistribute these same applications publicly. Many Commercial Off-The-Shelf (COTS) applications are available for Windows NT that may not have been written to conform to the quality required by your software projects.

This feature rich, general-purpose operating system provides the user a base operating system that has many resources and tools readily available for ease of

application development. Windows NT also has many built-in features that make it attractive to new markets in addition to the business desktop environment where it is widely known. Its security and networking features ensure that data collected is readily available to the right people at the necessary time. The Graphical User Interface (GUI) functions on Windows NT are easy to use and provide a common set of tools and services for application development, resulting in windows with a look and feel that have become the standard for many GUI programs. Although this functionality provides many benefits to the application developer and the end user, a major drawback of this operating system is a non real-time and non-deterministic environment.

REAL-TIME EXTENSIONS TO WINDOWS NT

Hyperkernel is a real-time kernel that runs in parallel with the Windows NT operating system and provides the necessary real-time and determinism required by many of today's applications. Developers can still use the entire feature set and all the openness provided by Windows NT, while Hyperkernel provides the functionality to extend Windows NT into the real-time and deterministic world. The Win32API (Application Programming Interface) is available through Windows NT and provides users a common function set for all their non real-time requirements, thus providing a standard API that is widely known and accepted. The Hyperkernel extends this functionality through the addition of a real-time API that provides only the extra functionality that is required by real-time applications.

Figure 1 is an architectural diagram depicting how a Hyperkernel scheduler (Hyperkernel Hardware Interface) has been implemented directly on the Intel processor. This interface resides below the Hyperkernel kernel and the Windows NT Hardware Abstraction Layer (HAL). The interface allows Hyperkernel control of the PC and prevents the existence of unnecessary latencies introduced by Windows NT on your real-time system. The Hyperkernel Hardware Interface provides a context-switching algorithm that allows Windows NT and Hyperkernel to share the processor for equal time ticks. Hyperkernel is a fully preemptive subsystem that immediately routes Hyperkernel interrupts directly to

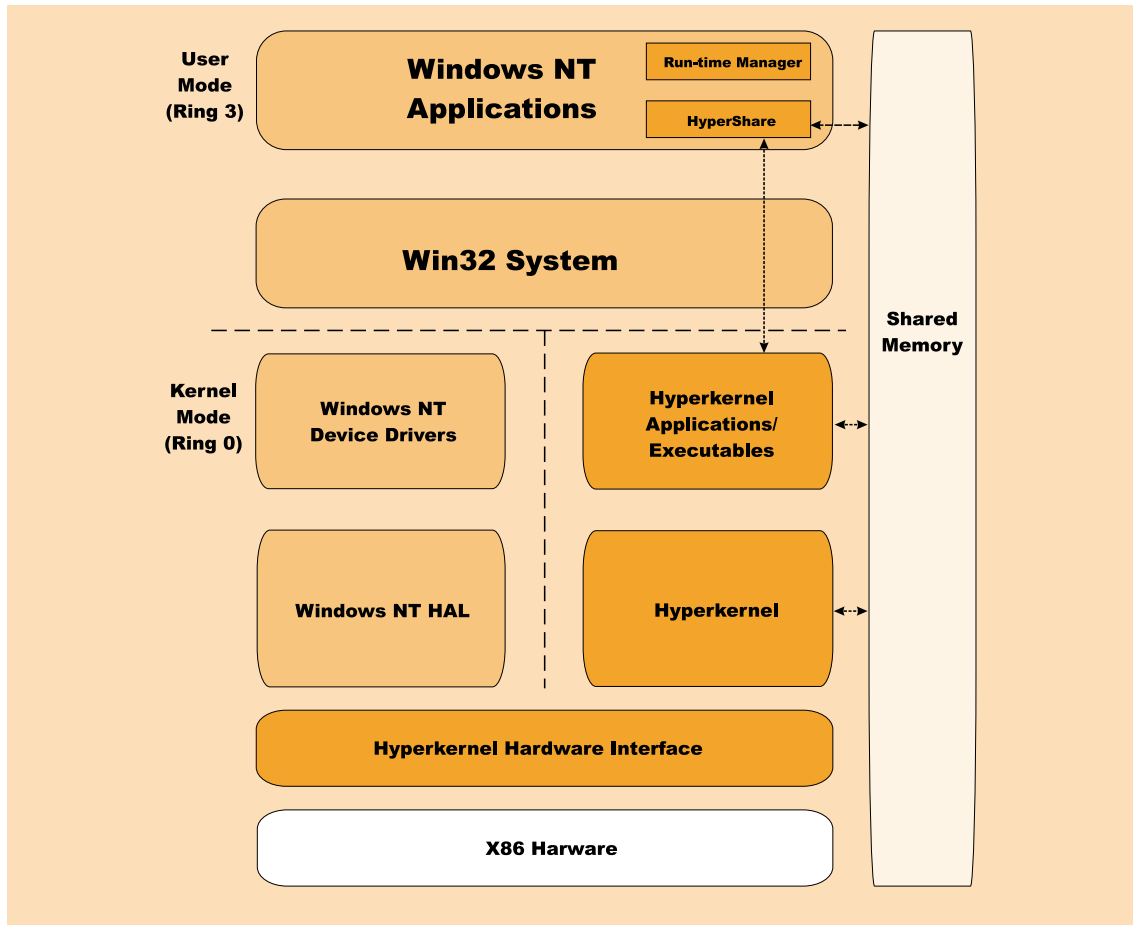


Figure 1. Hyperkernel scheduler implemented directly on the Intel processor

the appropriate Hyperkernel Interrupt Service Routine (ISR), regardless of which system is currently in control of the processor at that time; Windows NT interrupts are processed when Windows NT receives its time slice. The kernel of Hyperkernel resides in a separate, isolated area in RAM shielded from Windows NT and its applications. Hyperkernel applications execute in a self-contained execution environment within this RAM location that does not exist within Windows NT context or environment. This self-contained execution environment allows Hyperkernel applications to have an average interrupt latency of less than 5 microseconds and allows continuation of the execution of all your standard Windows NT applications. Hyperkernel itself is a robust real-time kernel providing all the services necessary to develop a complete real-time application, as well as the mechanisms that allow Windows NT and Hyperkernel to communicate and share data. This technology has allowed Windows NT to be used for many applications that were previously only possible through the use of Programmable Logic Computers (PLCs) or dedicated processors.

Hyperkernel also provides many tools and technologies, accessible from Windows NT, that give users direct access to the Hyperkernel information. The Hyperkernel Runtime Manager (RTM) provides the ability to run Hyperkernel applications from within the Windows NT User Layer and to monitor the status and data from these Hyperkernel threads. The Hyperkernel Trace Debugging Utility enables the user to trace

through the exact events that are happening in real-time within the Hyperkernel system. The trace kernel uses both start and stop triggers to determine when events are recorded to the trace buffer, giving the user complete control over what is recorded within his application.

Windows NT, however, has some negative aspects that are not overcome directly by using the extensions, such as price and memory footprint. These aspects become real issues on very small, focused, centralized applications and on applications where cost, size of memory available, and power requirements are important. Microsoft has attempted to overcome these limitations with two new products -- Embedded NT and Windows CE.

EMBEDDED NT

Microsoft has announced the pursuit of a new variation of the Windows NT operating system called Embedded NT. Although this product at first appears to be a competing operating system with Windows CE, Microsoft believes this system to be more a complementary product to Windows CE than a competing one. The Embedded NT remains a PC operating system that can be installed directly onto a standard PC. This version of Windows NT has a customized version of the standard operating system that maintains compatibility with all NT applications and drivers. This compatibility allows users to scale down, in memory requirements and price, their Windows NT operating

system to develop a customized system with only the portions of NT that are required by their applications. Embedded NT, however, is only in the preliminary consideration and design phase and some time must pass before it is a fully tested and released product.

WINDOWS CE

The latest embedded operating system that appears to be taking all the headlines is Windows CE by Microsoft. Windows CE, a feature rich embedded operating system, inherits the technology and tools that are currently available on Windows NT and Windows 98. This inheritance results in a very short learning curve for application developers; they have all the benefits of an embedded operating system and can use a familiar environment for their application development.

Microsoft is devoting many resources to promoting this latest version of the Windows operating system. Although it carries the Windows name, Windows CE is fundamentally different from the other Windows operating systems since Windows CE is a true embedded operating system. Applications are created, modified, and tested on a PC, then downloaded to a CE hardware platform for execution. Windows CE is not an off-the-shelf floppy disk or CD-

installable operating system, thus enabling customization of the operating system through writing a hardware-compatible OEM Adaptation Kit (OAK) designed to meet specific customer needs. The operating system is licensed to OEMs and is loaded on a hardware platform to be sold to the end user. The drawback to this approach is that it could lend itself to the creation of another proprietary operating system, where flexibility and accessibility to the operating system functionality would be limited. The benefits of this approach, however, are its flexibility and modularity. Windows CE also creates the problem of driver rewrites for ported

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applications. The extensive peripheral device support available for Windows NT and Windows 98 is not currently provided for Windows CE but should be available eventually.

So, why use Windows CE? Windows CE provides many benefits that are not available on standard Windows NT operating systems. Windows CE reduces the resource requirements necessary to run real-time applications, which has a direct impact on the cost, size, and power requirements of the target platform. Applications, as well as the operating system itself, may be scaled down to minimal application requirements. What makes Windows CE different from other embedded real-time operating systems is that it allows this functionality, while also opening up the platform to the many features and benefits of Windows NT. The run-time license for Windows CE costs substantially less than that of Windows NT, allowing developers who do not necessarily need all the power and features of Windows NT to have a cheaper, more streamlined application.

Microsoft's intention to create a hard real-time version of Windows CE enables this technology to be taken into many industries that require a high level of determinism for their applications. An RTOS working group, as part of the Open Modular Architecture Control (OMAC) committee, is working with Microsoft to provide input on Windows CE enhancements that would be beneficial to the RTOS developer. Timing of this real-time version becomes an important factor in the widespread use of Windows CE. An upgrade is tentatively scheduled for release in the spring of 1999. Once scheduling delays and problems are found and corrected, there will exist some time frame necessary for application developers to create and test their products, as well as test the operating system stability itself.

Microsoft Windows has been criticized for lack of stability; this stigma must be overcome for Windows CE to gain market acceptance for use in machine control and other time critical and sensitive embedded applications. Windows CE, however, is a new operating system, not an upgrade or re-write of Windows NT. It is smaller and written for a different, more concise and concentrated purpose. This direction is a new path on the Microsoft road map and they must instill confidence that Microsoft can create an operating system that is far removed from their normal approach to operating system design. Is Windows CE for you?

THE FUTURE OF WINDOWS - WHICH ONE DO YOU CHOOSE?

We anticipate a combination of these operating systems working together to make use of all the benefits that Windows can offer. Imagination Systems, Inc. continues to support Hyperkernel on all current versions of Windows NT, as well as through new releases (such as Windows NT 5.0). With respect to Windows CE, we plan to enable your Hyperkernel applications to run on Windows CE, once Microsoft has released Windows CE as a deterministic operating system. A Hyperkernel Portability Layer (HPL) allows your Windows NT/Hyperkernel applications to be recompiled on

Windows CE. These applications (with little or no modifications) can then be executed on Windows CE. One nightmare that exists when applications are ported to multiple operating systems is the driver rewrites. The HPL gives users the flexibility of using existing Hyperkernel drivers, as is, on Windows CE. Application developers gain versatility as their applications and drivers are operating system independently.

So, what does this mean to you? You do not have to decide today which operating system is best for your application. Users can develop their applications on Hyperkernel using Windows NT tools today and decide at a later time (once real-time Windows CE is available and ready for real world deployment) whether Windows CE provides any extra benefit to your application. If you have already decided to use Windows CE for your run-time applications, you can still use all the familiar Windows NT development tools to create, compile, and test your applications on your desktop PC, with no additional tools required!

This interoperability is a major benefit to many developers. Windows NT gives users an open system with an abundance of applications; however, Windows NT lacks determinism. Microsoft has already stated that Windows NT will be their PC operating system of choice for the future and presently has no plans for implementing real-time. Using Windows NT, with a stable real-time extension, provides a number of tools and products for demanding applications that require total information integration between machine control / data acquisition on the plant floor and the information system used within a company. Windows CE is an embedded operating system. Although it has been adapted to run on a PC platform, Windows CE is not a PC operating system. Windows CE can be viewed as a complement to Windows NT; providing windows-based technology in an embedded arena with direct communications and data sharing to SCADA, HMI, and data acquisition software packages. These packages can be from multiple vendors for a variety of different uses and may be accessed from remote sites over the Internet through customized HTML pages.

Whether your applications call for embedded customized real-time systems on Windows CE or large networked machine control applications on Windows NT with real-time extensions, Microsoft technology is available. You can have the best of all worlds as the lines between operating systems start to blur and the future really is open. ■

Rhonda Landis is the Vice President of Software Development for Imagination Systems, Inc. (ISI) based out of Virginia Beach, VA. Rhonda has been working for ISI for 3 years. Rhonda's previous experience, working for UNISYS, includes 11 years in real-time operating system programming and project management for Naval Defense programs. Rhonda has BS in Computer Science and a Masters in Business Administration. Rhonda is responsible for AutoNet, data acquisition and monitoring system; PowerVIEW, panel replacement software, OpenControl, PC based control software; and Hyperkernel, real-time extensions for Windows NT.