NATIVE SIGNAL PROCESSING AND NATIVE AUDIO

April 1995

Native Signal Processing

Native Signal Processing (NSP) offers multimedia and communications solutions providers the tools needed to execute signal processing functions in the Windows* environment directly on the Pentium® processor and soon on the P6 processor. The goal of the NSP Initiative is to provide a common base of multimedia and communications functions that PC OEMs, IHVs and ISVs can build and innovate upon. With NSP, system designers have the option to replace many of the functions of today's mainstream, commodity multimedia and communications signal processing hardware with 32-bit software running on a Pentium or P6 processor. Primary applications for NSP include PC audio, software video compression and decompression, video capture, speech recognition and communications processing.

Native Signal Processing (NSP) technology allows system designers to take advantage of a high performance environment as defined by Intel's NSP Reference Platform. Unlike existing 486 generation PCs, with their collection of '80s bus architectures, graphics subsystems and memory interfaces, new NSP-enabled, Pentium and P6 processor-based PCs will be built using a highly efficient combination of advanced software and hardware technologies.

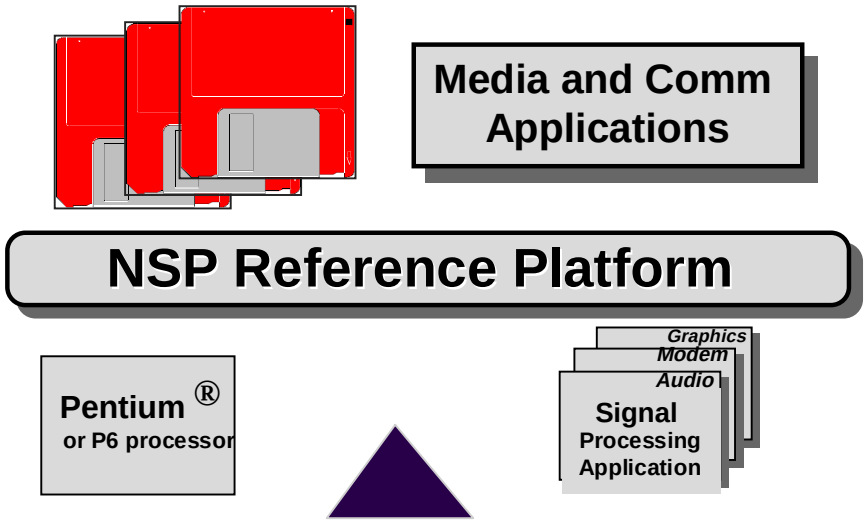
NSP Industry Initiative

The NSP initiative being pursued by Intel and its industry partners addresses three areas:

- Development of an NSP Reference Platform for desktop and mobile PCs
- Development of NSP software technology and tools (IA-SPOX™, NSP Library, and compiler tools)
- Development of NSP infrastructure and core ingredients (including Indeo™ video, DCI, 3DR, Native Audio, Desktop Management Interface, Plug and Play, Power Management and InstantOn, third generation PCI chipsets and Bus Master IDE).

In 1995 Intel's NSP activities will focus primarily on multimedia with "Native Audio" taking the lead. In 1996 the focus will expand to address communications. The NSP Reference Platform and Native Audio driver offer new business opportunities for OEMs, IHVs and ISVs to create new products and applications designed to take advantage of the power of the Pentium and P6 processors.

NSP Reference Platform



The NSP reference platform identifies and provides solutions in five crucial areas:

- **Rich Media** -- Rich Media includes the ability of a system to present and manipulate data beyond simple text and static graphics. It is high-quality, inexpensive, integrated desktop media (audio, video, and graphics).

- **Connectivity** -- Connectivity is the ability of an end user to receive information without having to care whether it resides on the user's PC, across a business network, through an on-line service, or elsewhere.

- **Ease of Use** -- Ease of Use is the ability of the system to easily incorporate or adapt new hardware and software to without requiring intervention on the part of the user to set jumpers or deal with IRQ or DMA settings. It is integrated Plug and Play for easy installation, configuration, and system startup.

- **Manageability** -- Manageability is the ability to provide easy to use, energy-efficient, always available PCs.

- **Scalable Performance** -- Scalable Performance is expandable processor and I/O bandwidth for today's and tomorrow's applications. It is also the ability of the system to deliver the full performance of the expansion with without encountering any unexpected bottlenecks in the system.

Native Audio Overview

The PC market is quickly adopting audio as a standard feature. The PC audio market's evolution in many ways mirrors what has already taken place in the PC graphics world. As VGA and SVGA subsystems moved to the motherboard, basic audio capability is migrating to the mainstream platform while accelerated and advanced audio products continue to be created to meet the demands of audio enthusiasts and professionals.

Audio is one of the first technologies that will significantly benefit from NSP technology. The computing power of the Pentium and P6 processors make it possible for these processors to handle complex signal processing functions for audio that traditionally have been executed by dedicated subsystems with their own fixed function signal processing hardware.

Intel's Native Audio software technology provides an enhanced, extensible and open Windows audio driver which enables high-end audio functionality (digital mixing, sample rate conversion, wavetable MIDI, ADPCM compression/decompression, special effects) to be managed on the Pentium processor (and ultimately on the P6 processor) using standard low cost audio codecs. For audio applications requiring real-time services (such as speech recognition, speech-to-text, and Wavetable MIDI) Native Audio can be combined with IA-SPOX™ to provide real-time services under Windows.

Native Audio can be viewed as a natural progression for audio signal processing on the PC. A similar progression has already taken place in the LAN adapter and graphics subsystems world where separate processors were once required to support these functions. As the host processor power increased, IHVs of these products quickly moved key functions to the host allowing them to concentrate on features and accelerators designed to address special problems. Native audio offers PC OEMs and IHVs an opportunity to choose the right ***balance*** of NSP-based audio and hardware assisted acceleration for each application.

Key features and capabilities offered by Intel's Native Audio technology include:

- Ability for multiple Windows applications to be open and play or record audio (eliminates "device busy" messages in Windows when more than one audio stream attempts to play/record).
- Digital mixing to play multiple audio streams concurrently, and to enable multiple audio applications to simultaneously share the audio hardware.
- ADPCM compression/decompression support to minimize memory utilization requirements, and provide compatibility with this industry standard compression algorithm.
- Full duplex support for simultaneous recording and playback (a feature required for PC video teleconferencing and telephony management applications).
- A sound mixing utility offering end users the ability to control global audio parameters, including volume control for individual audio streams.

- Complements SoundBlaster* support for DOS-based applications by providing an advanced Windows-based audio driver.

- Fully extensible in both hardware and software to:

    - Support transformations of any audio stream or compression algorithm
    - Provide transparency between the Native Audio driver and the hardware running underneath it
    - Support real-time services via IA-SPOX.

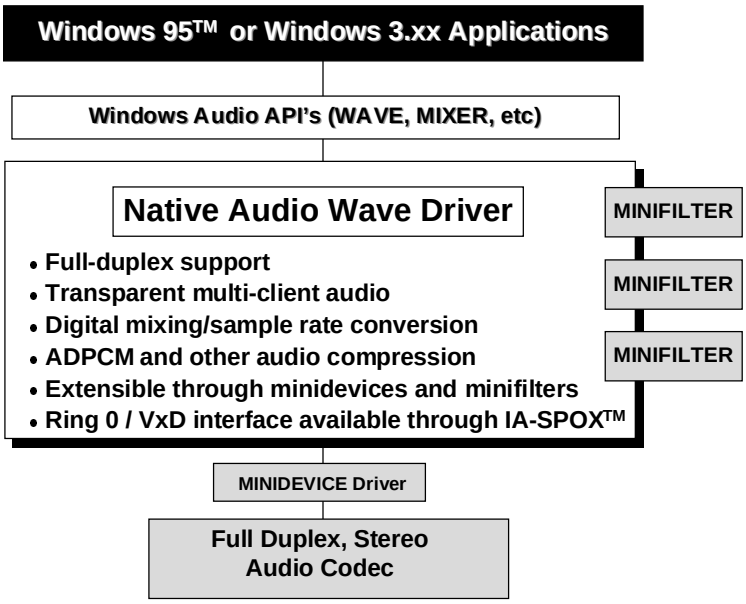
- Initial version of Native Audio is compatible with Windows 3.1 and Windows™ 95.

Native Audio Performance Characteristics

The Pentium and P6 processors are capable of executing the complex but commonplace signal processing functions required by today's mainstream multimedia audio applications. Functions such as audio playback, digital mixing, sample rate conversion and ADPCM compression are all readily managed with a minimal amount of CPU overhead required.

Mainstream users can now enjoy audio capabilities that were not available previously on standard sound card subsystems. Software developers can utilize these new functions while writing their new applications knowing they are part of the base platform. Hardware solutions providers can provide families of balanced and differentiable solutions. Advanced compression algorithms such as Truespeech, DigiTalk and GSM or software wavetable synthesis can also be executed on the Pentium processor (and soon on the P6) taking a moderate amount of CPU overhead. It is these types of functions that hardware solutions providers will target their signal processing accelerator development efforts to deliver accelerated and feature-enhanced solutions.

Native Audio Driver Architecture

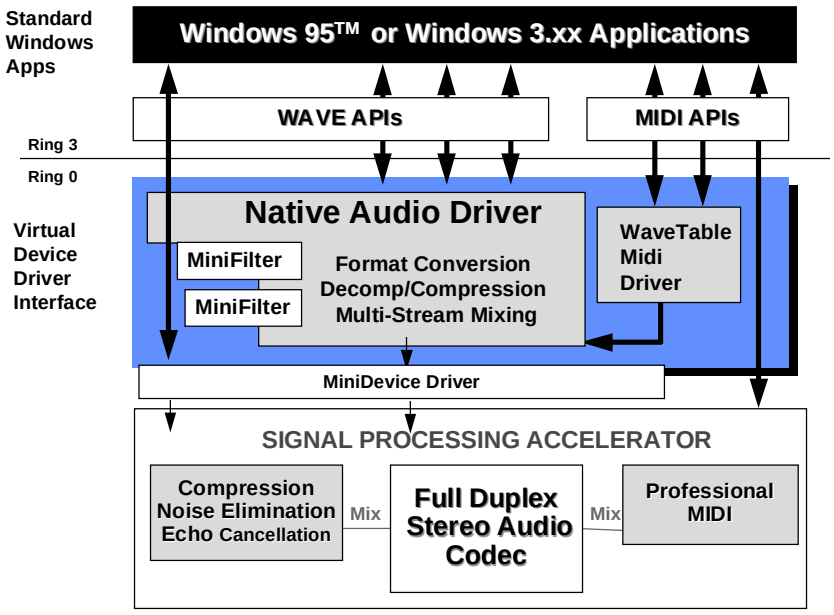


From an architectural point of view, Native Audio represents the application of NSP technology to audio to create a Windows Wave driver. It functions as a virtual device driver within the Windows operating system. Native Audio is a Windows MMSYSTEM device driver that implements the WAVE and MIXER APIs and executes the requested function in software on the processor. In turn, the Native Audio driver then works directly with the audio hardware (codec).

The simplest Native Audio-based subsystem implementation includes the Wave driver and a "minidevice" driver (which provides a hardware abstraction layer for transparency between the Native Audio driver and the audio codec). The minidevice driver enables designers to employ any full duplex, stereo audio codec they wish. The result is an audio subsystem offering enhanced features not currently available on audio subsystems today.

Native Audio Extensibility

Native Audio Driver Architecture



The Native Audio architecture is extensible in both hardware and software. Extensibility in software is provided in three ways:

1. With MiniFilters custom transformation of any audio stream can be supported. This transformation feature can be applied to compression schemes such as Digitalk, TrueSpeech and GSM. Special effects processing such as reverb, chorus, echo and stereo enhancements are also implemented using the Minifilter interfaces. For example, the Native Audio implementation of ADPCM is made possible via a MiniFilter.
2. A Mini Device Driver in the hardware abstraction layer provides transparency between the Native Audio driver and the audio hardware executing underneath it.
3. For applications requiring real-time services, such as text-to-speech, voice recognition, MIDI wavetable, etc. the Native Audio environment may be further extended by combining it with IA-SPOX (which provides real time services in Windows for NSP applications).

The Native Audio architecture provides hardware extensibility by enabling the designer to strike the right balance of those functions to be handled by the Pentium or P6 processor, and those functions (depending on the application) that can be accelerated by additional

specialized hardware. Examples of applications where a mix of the processor executing signal processing and additional acceleration hardware makes sense today include advanced compression algorithms, noise elimination, echo cancellation and professional class MIDI.

Native Audio and SoundBlaster compatibility

Native Audio is a Windows only audio driver, SoundBlaster or 'games' compatibility is a DOS hardware standard. Native Audio complements Sound Blaster compatible subsystems/devices by providing a complete and feature-rich audio subsystem for Windows and DOS.

Native Audio Hardware Requirements

- Pentium or P6 processor-based PC
- 8 Mb of RAM
- Standard full-duplex, stereo audio codec
  ⇒ (option to use SoundBlaster or Games Compatible codec)

Availability and More Information

Intel's Native Audio software is licensed free of charge, with no royalty fees for usage. A Native Audio Developer's kit is available directly from Intel. For more information about Native Audio, or more information about NSP in general, use Internet e-mail address nsp@intel.com, or contact your audio hardware solutions provider to see if they support the Native Audio technology. The Native Audio driver is also included in Spectron Microsystems' IA-SPOX developers kit. For information on Spectron's kit, use Internet e-mail address iaspox@spectron.com.