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Intel in Communications

Voice over IP Solutions

Intel® IXP421 and IXP425 Network Processors

Voice-Telephony Integration in CPE Devices

Voice over IP (VoIP) is the transport of voice packets over an Internet Protocol network. The industry now has the opportunity to provide home and small office/home office (SOHO) users with cost-effective customer premises equipment (CPE), integrated access device (IAD) and SOHO PBX solutions capable of delivering converged voice and data services over a single broadband or cable connection. VoIP applications require digital signal processing (DSP) capabilities to provide voice codec, telephony tone handling, interactive voice response (IVR), speech recognition and personal dial prompt. The challenge is how to provide these capabilities in a scalable solution while maintaining low cost.

The Challenge:
Reduce Complexity and Cost

Device manufacturers serving the CPE and IAD market segments require flexible and low-cost digital media signal processing solutions. The conventional approach of adding DSP capability through a separate chip leads to higher bill of materials (BOM) costs and increases the complexity and cost of platform integration.

The Solution:
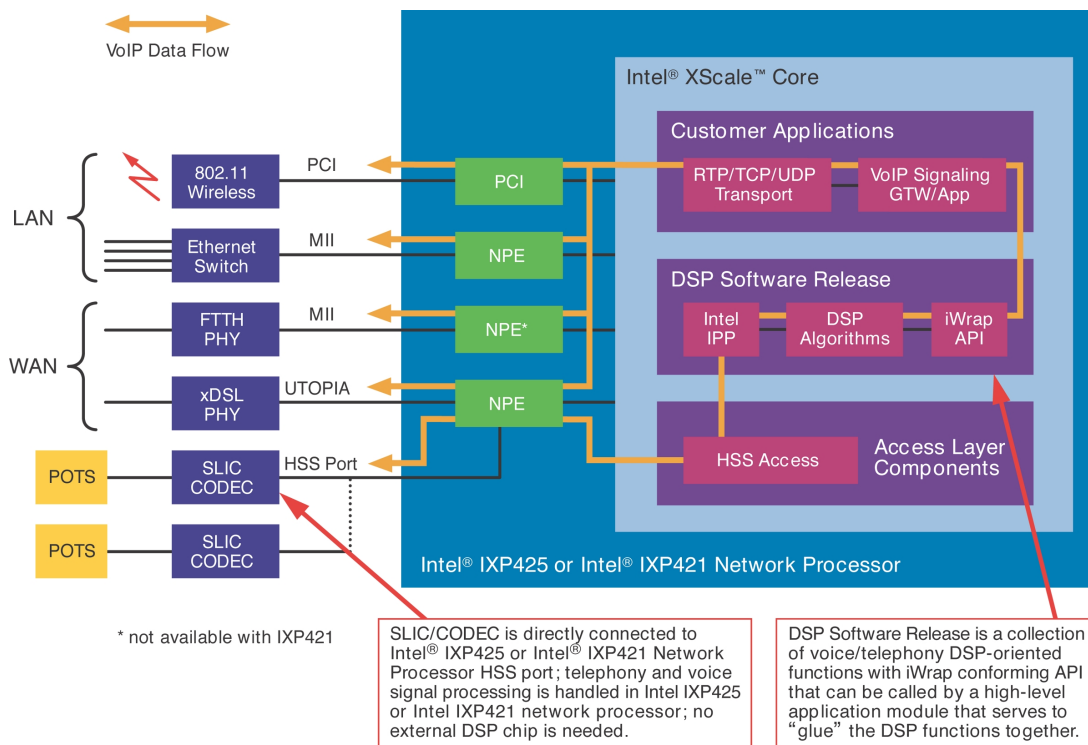**Intel® IXP421 and IXP425 Network Processors and Intel® IXP4XX DSP Software Release**

Intel offers a choice of two network processors optimized for voice applications. The Intel® IXP421 network processor supports cost-effective VoIP CPE and IAD designs. The network processor features the integration of a high-performance 266 MHz Intel® XScale™ core with two programmed network processor engines (NPEs). The Intel® IXP425 network processor implements the same, high-performance architecture as the IXP421. For additional performance, the IXP425 integrates three NPEs, and is available in 266 MHz, 400 MHz, and 533 MHz core speeds.

Each NPE is a hardware multi-threaded processor engine with separate instruction/data memory for fast local code and data store. The NPEs complement the Intel XScale core for many computationally-intensive data plane operations including IP header inspection and modification, packet filtering, packet error checking, checksum computation and flag insertion and removal.

By offloading these packet handling tasks, the NPEs enable high levels of application processing including DSP on the Intel XScale core. The unique distributed processing architecture enables these network processors to meet the growing performance requirements of VoIP applications. These processors also feature two high-speed serial (HSS) ports enabling direct connection to standard Subscriber Line Interface Circuit/Coder-Decoders (SLIC/CODECs).

The Intel® IXP4XX DSP Software Release, released as object code, is an integral part of the Intel IXP4XX network processor software product line. Closely related to the Intel® Integrated Performance Primitive (IPP) software library, the DSP software release adds capabilities for software-based voice and telephony DSP capability, including G.729A voice codec and G.168-compliant echo cancellation using the Intel XScale core in the IXP421 and the IXP425 network processors. By moving voice signal processing tasks onto the Intel XScale core, this software solution eliminates the requirement for additional DSP hardware, thereby reducing BOM costs.

The Intel IXP4XX DSP Software Release also enables developers to build a voice-enabled CPE and IAD solution without having to master complex digital voice signal processing algorithms or needing to optimize assembly code on the Intel XScale core. The DSP software release is useful for any customer application that targets low-density VoIP service-enabled CPE and IAD applications. Currently providing support for both VxWorks* and Linux* operating systems, the DSP software release will expand as new applications emerge.

VoIP Data Flow

Intel® XScale™ Core

Customer Applications

RTP/TCP/UDP Transport | VoIP Signaling GTW/App

DSP Software Release

Intel IPP | DSP Algorithms | iWrap API

Access Layer Components

HSS Access

LAN

802.11 Wireless — PCI

Ethernet Switch — MII

WAN

FTTH PHY — MII

xDSL PHY — UTOPIA

POTS — SLIC CODEC — HSS Port

POTS — SLIC CODEC

PCI

NPE

NPE*

NPE

Intel® IXP425 or Intel® IXP421 Network Processor

* not available with IXP421

SLIC/CODEC is directly connected to Intel® IXP425 or Intel® IXP421 Network Processor HSS port; telephony and voice signal processing is handled in Intel IXP425 or Intel IXP421 network processor; no external DSP chip is needed.

DSP Software Release is a collection of voice/telephony DSP-oriented functions with iWrap conforming API that can be called by a high-level application module that serves to "glue" the DSP functions together.

Example Application and VoIP Data Flow using the Intel® IXP421 or IXP425 network processor and the Intel® IXP4XX DSP Software Release

VoIP IAD Application Example

In an IAD, the WAN connection is provided through either xDSL or FTTH (Ethernet). Voice signals from standard POTS phone sets connect through the POTS connector to the SLIC/CODEC. The IXP421 or IXP425 network processor connects directly to the SLIC/CODEC through its HSS port. Depending on the interface used, the SLIC/CODEC can require additional control connections through GPIO. The only major external hardware required is the SLIC/CODEC.

The Intel® IXP4XX DSP Software Release provides both algorithm level entry points (APIs) and performance primitives in a high-level application module that enables the movement of voice payloads to the IP stack using a common control interface. The DSP software release communicates through the HSS access API with the SLIC/CODEC for voice data flow. Under control of application layer software, the software release handles voice and telephony signal the DSP tasks, such as echo cancellation, compression/decompression and tone detection. The compressed voice signal then passes to the transport layer such as RTP/TCP/UDP managed by application layer and signaling/gateway software such as MGCP, H.248, or SIP, for transmission out over the physical link (xDSL or FTTH). The signaling protocol stack is not part of the Intel IXP4XX DSP Software Release.

Reducing Complexity and Cost

Because the Intel IXP421 or IXP425 network processor handles telephony and voice signal processing, no external DSP chip is needed. This enables developers to use the processing power of the Intel XScale core for a VoIP-enabled solution. The integration of networking and signal processing under a unified software architecture, coupled with a range of clock speeds

(266 MHz to 533 MHz) for the Intel XScale core, provides scalability and enables future application expansion based on the Intel XScale technology. The Intel IXP4XX DSP Software Release solution allows developers to utilize one code base instead of separate DSP hardware and software, and provides seamless integration with networking and security capabilities for new generations of cost-competitive products.

Development Platform for Faster Time-to-Market

The Intel® IXDP425 Network Processor Development Platform is a powerful tool for development and verification of hardware and software for the Intel IXP4XX product line. Using a common development platform across the product line helps reduce costs and speeds development by providing a consistent tools/development environment. Developers can use this flexible and extendable platform to conduct rapid initial chip evaluation, chip performance evaluation, product development and prototyping. Pin compatibility among members of the IXP4XX product line further reduces hardware design complexity.

Tools, Applications and Operating Systems Support Rapid Development

Intel XScale technology includes a broad range of development tools and applications, together with support for multiple operating systems. The Intel IXP4XX product line currently supports Wind River* VxWorks and the standard Linux 2.4 kernel. Associated third-party products are available for the IXP4XX product line including Wind River Tornado* 2.1.1 for VxWorks 5.4 and the

MontaVista* Linux Professional Edition. Multiple third-party vendors also provide application stacks and advanced development environment support.

To help speed time-to-market and reduce development costs, developers have a wide choice of Intel XScale technology-based tools. The Intel IXP421 and IXP425 network processor may be controlled during debug through a JTAG interface to the processor. The Macraigor* Raven*, Wind River Systems visionPROBE*/visionICE* and EPI* MAJIC* systems plug into the JTAG interface through a 20-pin connector.

Scalable Intel® IXP4XX Network Processors

The IXP421 and IXP425 network processors are members of the Intel IXP4XX product line, a range of highly integrated and versatile products that can be used in a variety of applications that require a combination of network connectivity, integrated functionality and high performance. With their distributed processing architecture and integrated support for multiple WAN and LAN technologies, Intel IXP4XX product line provides the benefits of a common architecture and a pin-compatible footprint, while delivering wire-speed performance that enables manufacturers to add a variety of rich software services.

The flexibility of the IXP4XX product line simplifies the task of choosing a processor to support the number of voice lines required in a specific VoIP application.

- The Intel IXP421 network processor at 266 MHz, provides the processing headroom for both the Intel IXP4XX DSP Software Release and VoIP stacks needed to support up to two voice channels.
- The Intel IXP425 network processor provides a range of core frequencies, including 266, 400 and 533 MHz and provides a number of additional interfaces to allow further integration. The IXP425 is also available in commercial and extended temperature variants. At 400 MHz and 533 MHz, the IXP425 is capable of supporting higher-density VoIP services.

The Intel Advantage: Years of VoIP Experience

Intel® communications building blocks reflect years of accumulated VoIP expertise. Intel is at the forefront of the convergence of voice and data, providing the necessary hardware and software building blocks for a complete modular communications network solution. Through continuous innovations in connectivity and processing in the network, Intel is delivering a wide choice of solutions that enable faster time-to-market, longer time-in-market, and increased revenue opportunities.

Intel Access

Communications Processing Web page	http://www.intel.com/go/commsprocessing
Intel® Network Processors Web page	http://developer.intel.com/design/network/products/npfamily/
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General Information Hotline	(800) 628-8686 or (916) 356-3104 5 a.m. to 5 p.m. PST

For more information, visit the Intel Web site at: developer.intel.com