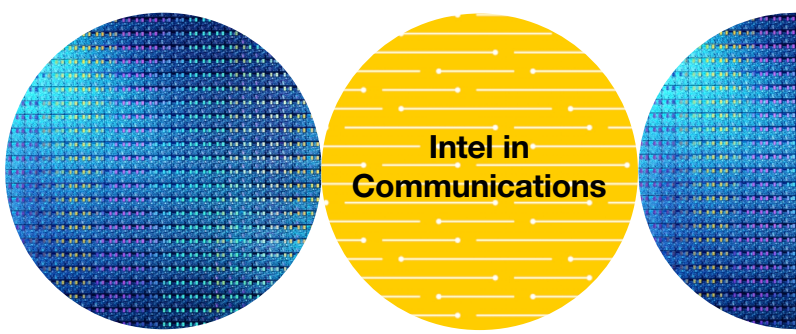
White Paper

Intel® Network Infrastructure Processors

Extending Intelligence in the Network



April 2003

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Intel's line of network infrastructure processors, led by Intel® Internet Exchange Architecture (Intel® IXA) network processors and Intel® Architecture processors for communications, is continuing to expand, making it easier for equipment manufacturers to distribute high-performance processing where and when it is needed in today's modular networks. Intel's advanced network infrastructure processor families provide the performance, functionality, development tools, and software required to extend intelligence in the network, enabling more flexible, cost-effective designs, faster time-to-market and richer services.

Introduction

Business conditions in the communications industry have made revenue generation the number one priority. As service providers place increasing emphasis on the deployment of complex content-based services in order to create new sources of revenue, equipment manufacturers must meet a new set of challenges. With today's demanding market conditions, the ability to deliver solutions on fast time-to-market development cycles has never been more crucial. New generations of communications and networking equipment must deliver the processing performance needed to handle the growing menu of media-rich network services at ever-faster wire speeds. To be competitive, communications equipment must be designed on modular and flexible hardware platforms that can help service providers minimize their operating costs and build return-on-investment.

The Trend to Distributed Processing

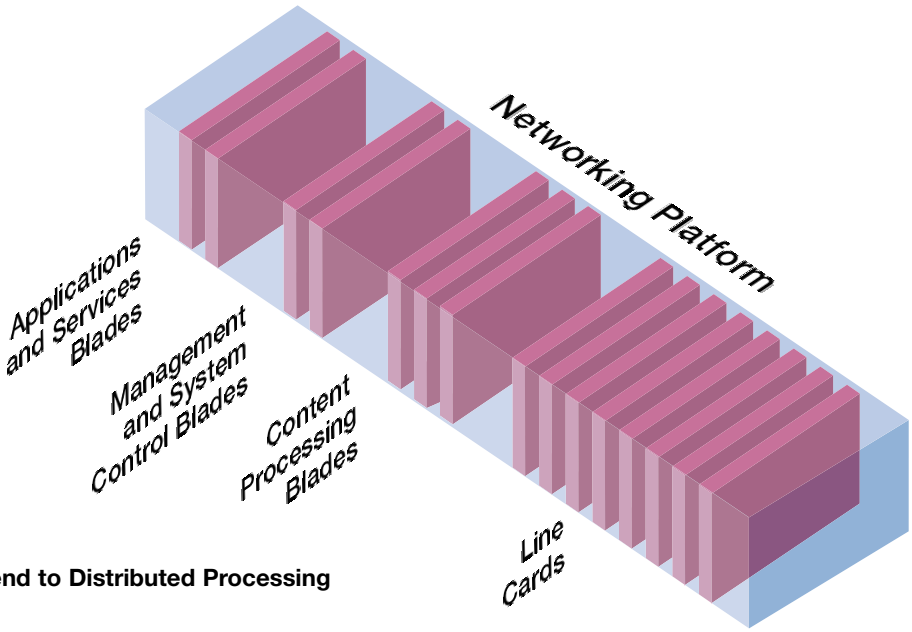
Faster line speeds, increased protocol complexity, and the need for more processing per-packet are driving the industry trend to distributed processing, or the addition of processing intelligence to networking platforms in specialized blades and in line cards "closer to the wire." Intel® network infrastructure processors are helping to extend standards-based high-performance processing into four key areas of the platform:

- **On the line card—**The line card is where line termination and I/O processing occur. It has seen rapid increases in processing performance, including the addition of control plane processing to handle the management of policies for execution in the data plane. Processing of connection management, route management, signaling and exception-handling is increasing on the line card as a supplement to system management and control blades. Network processors share space on the line card with control plane processors and provide flexible implementation of rich networking services at line rate. The line card can also feature a digital signal processor to support multi-channel IP-based services, including voice.

- **On the control blade—**The system's control blade, also known as the "shelf controller," provides centralized management of rack and system resources, including resource allocation, diagnostics, and fault management. The control blade also handles control plane functions not distributed to the line cards. Dual-redundant control blades are often implemented to ensure high availability in carrier-class equipment.

- **On the applications and services blade—** Appliance capabilities and processing of high-level network services are being added to blades in rack-mounted equipment as an alternative to dedicated servers. The applications and services blade supports security applications and the management of policy-based high-value services delivered over the network, such as accounting/billing and policy tracking.

- **On the content processing blade—** A separate content processing blade may be required to handle content processing, or intensive packet processing that is based on inspection of the packet payload, rather than just the header. Examples of content processing application areas include intrusion detection, service leveling, and voice processing enabled by a digital signal processor.



The Trend to Distributed Processing

Intel network infrastructure processors also address the needs of cost-sensitive network endpoint systems and network appliances where all components may be included on a single card. For these system-on-a-card solutions, increased processing intelligence is delivered by the single processor through increased integration of high-performance technologies that have been optimized for specific applications. Representative applications include wireless access points, residential gateways, and VPN appliances.

Intel® Network Infrastructure Processors

Intel now provides an extended family of network infrastructure processors that meets the increasing processing demands created by faster line speeds, the deeper packet inspection requirements of content-based services and the need to support multiple protocols and evolving industry standards.

- Now in their second generation, Intel IXA network processors provide industry-leading programmability and fast packet processing to meet the specialized requirements of communications equipment, ranging from the customer premises (CPE) to access, edge and the core of the network.
- Intel® IXC1100 Control Plane Processors are the first control plane processors with Intel® XScale™ technology. These high-performance, low-power processors extend the processing functionality provided by Intel IXA network processors on the line card and are designed to meet the additional control plane processing requirements of wireless infrastructure equipment, multi-service switches, Voice over Packet (VoP) media gateways, and other communications and networking products.
- With industry-leading processing performance, extended life cycle support, and the reduced power consumption of the Intel® Pentium® M processor for bladed form factors, Intel Architecture processors meet the growing demand for processing density, software reuse and scalability for compute-intensive control tasks, applications, and services.

Intel's growing portfolio of network infrastructure processors is complemented by other silicon building blocks, including high-throughput I/O processors for storage applications and a comprehensive range of physical layer devices that enable flexible network connectivity. For fast time-to-revenue, Intel network infrastructure processors are also supported by development platforms, reference designs, tool chains, software, complementary silicon, and services from Intel and its third-party communications developer programs.

The trend to distributed processing is underway across the spectrum of communications applications, as the industry seeks more flexible design solutions by adding new control and services processing functionality to line cards and blades. Intel network infrastructure processor families enable equipment manufacturers to extend intelligence in the network to support the delivery of a richer menu of revenue-generating services.

Intel® Internet Exchange Architecture (Intel® IXA) Network Processors

The demand for new services and lower costs is driving the trend toward distributed processing, which in turn creates a demand for higher performance, lower power, and more scalable processing solutions. Intel network infrastructure processors provide compelling processing solutions for communications systems, from cost-sensitive network endpoints to those requiring high-performance, content-based processing with integrated security functionality.

Intel® IXP4XX and Intel® IXP2XXX network processors are specifically designed to meet a range of packet handling requirements, from customer premises equipment (CPE) to access, edge and network core applications. These processors combine advanced multiprocessing features, the high performance and low power consumption of Intel XScale technology and an easy-to-use programming framework that enables flexible implementation of rich networking services at line rates up to OC-192/10 Gbps.

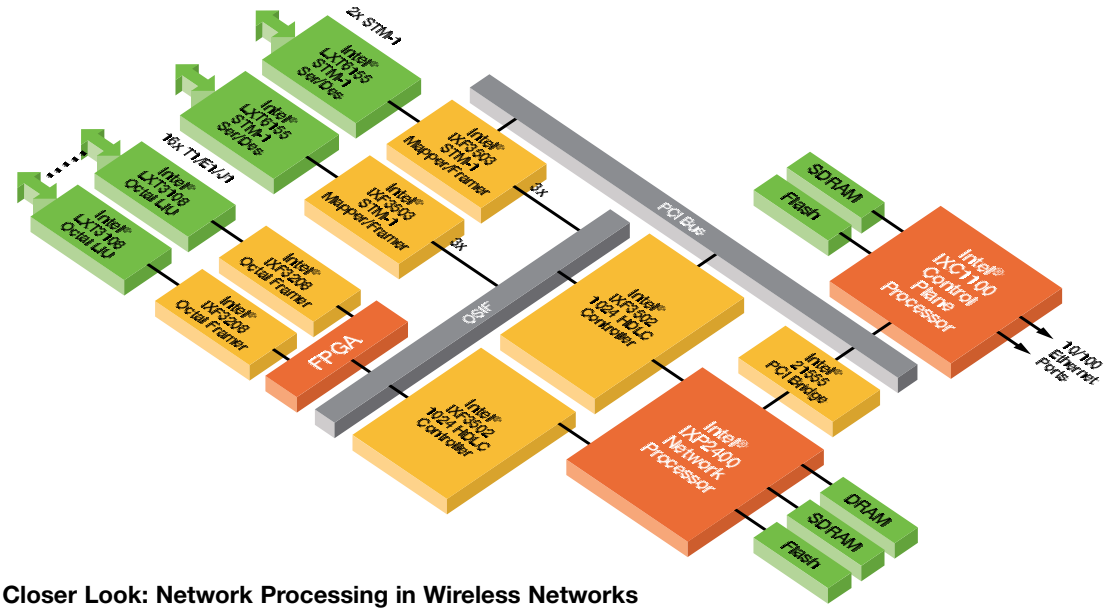
Intel® IXP2XXX Network Processors

The Intel IXP2XXX network processor product line integrates a high-performance parallel processing design on a single chip for processing complex algorithms, deep packet inspection, traffic management, and forwarding at wire speed. Its store-and-forward architecture combines a high-performance Intel XScale core with multiple 32-bit independent multithreaded microengines.

Intel has expanded the IXP2XXX product line with the Intel® IXP2850 network processor, which adds integrated cryptography engines that provide hardware acceleration of DES, 3DES, AES and SHA-1 algorithms to deliver IPSec encryption and decryption capability at up to 10 Gbps.

Intel® IXP4XX Network Processors

The scalable Intel IXP4XX product line provides developers with a range of speeds, interfaces and levels of integration to meet the needs of high-performance, cost-effective applications. With their support for multiple WAN and LAN technologies,



Closer Look: Network Processing in Wireless Networks

Closer Look: Network Processing in Wireless Networks

The Intel® IXP2400 is ideally suited to the infrastructure requirements of next-generation wireless networks. The fully programmable, highly scalable architecture of Intel's network processors provides a flexible platform to support migration to higher bandwidths and IP-centric 3G environments.

For example, customers are using Intel network processors to build line cards for Radio Network Controllers (RNCs). Each RNC collects radio signals from user aggregation sites, separating voice and data streams for subsequent transmission to circuit- and packet-switched networks. The IXP2400 provides sufficient headroom for packet/cell classification and forwarding at OC-12/1 Gbps, as well as traffic shaping and Quality of Service. In addition, the standards-based media interfaces of the IXP2400 ensure easy integration with ATM and Gigabit Ethernet networks.

these processors provide the benefits of a common architecture with the performance headroom to support rich software services.

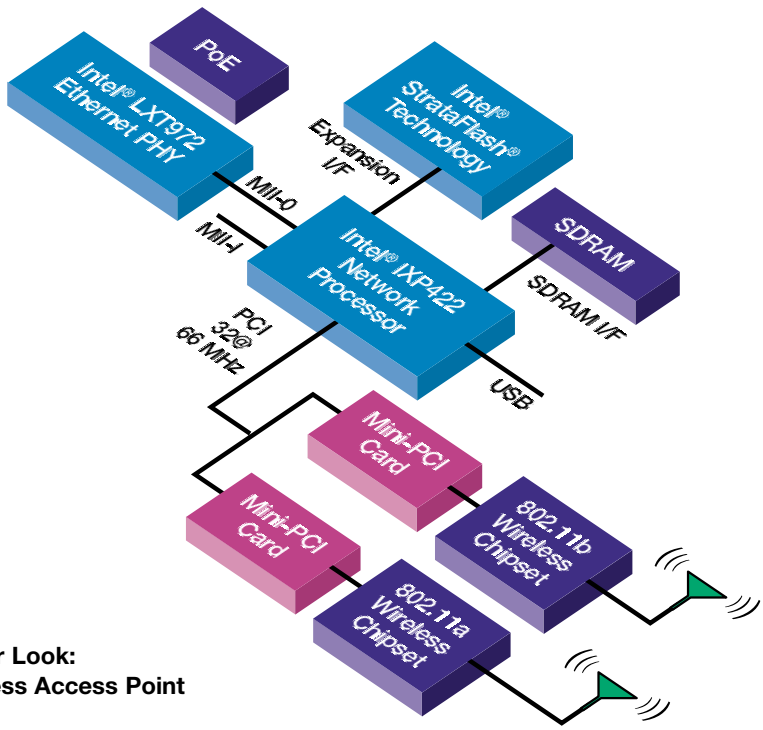
The Intel IXP4XX product line addresses a variety of wired and wireless applications for the home, small office/home office (SOHO) and small-to-medium enterprise (SME). The IXP422 network processor meets the requirements for residential gateways, wireless access points and SME routers and switches, including the provision of crypto-enabled security. The IXP421 network processor enables data plus Voice over IP (VoIP) applications, while the IXP420 network processor is optimized for residential broadband access applications. The IXP425, with the highest level of integration in the product line, meets the requirements for high-end residential gateways, wireless access points and security devices, as well as mini-DSLAMs and xDSL line cards.

Intelligent Packet Processing at Wire Speed

As network technologies and standards continue to evolve, the real value of network processor technology is its ability to provide intelligent packet processing at wire speed. As an example of the demands placed on a network processor, consider that at OC-192/10 Gbps, the available time interval for deep packet inspection at wire speed is just 35 nanoseconds. The network processor must perform the necessary Layer 3 through Layer 7 processing on incoming cells/packets and then transmit them in the correct sequence and at the required rate without loss. The multiprocessing subsystem of Intel's second-generation network processors provides aggregate processing capacity to handle applications that traditionally required high-speed ASICs, even at 10-Gbps wire speeds. This powerful and flexible network processor design will enable OEMs to easily scale performance and add features.

Intel® IXC1100 Control Plane Processors

With the Intel IXC1100 control plane processor, Intel is helping to meet the challenge of distributed control plane processing with industry-leading processor technology complemented by a comprehensive development platform with software and tools. The Intel IXC1100 control plane processor is



Closer Look: Wireless Access Point

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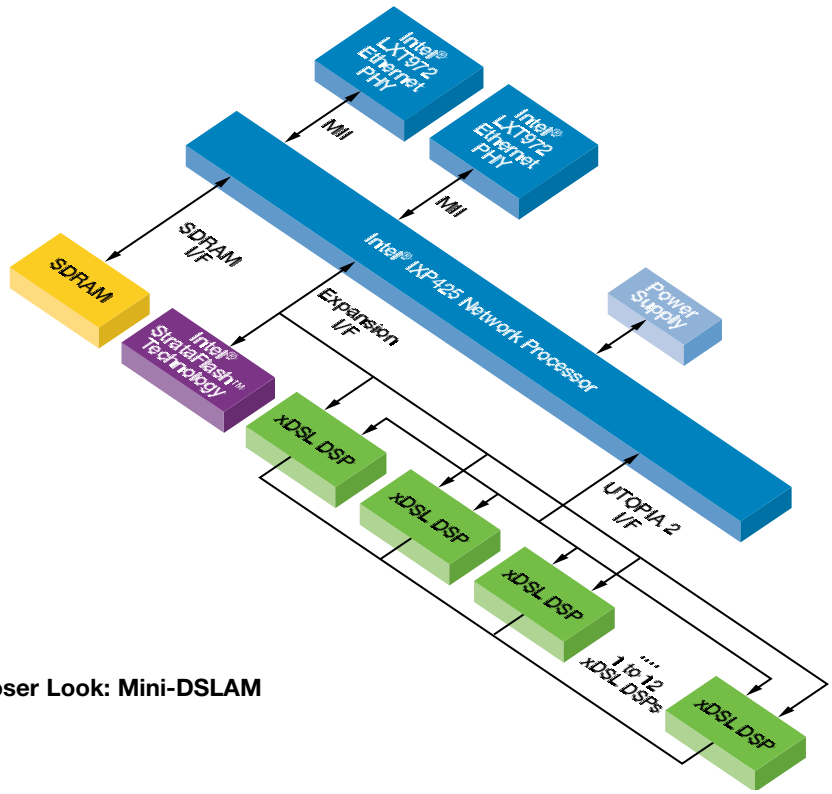
The wireless LAN market segment is growing rapidly, and as the technology matures, users place greater importance on wire-speed performance. The Intel® IXP422 network processor is being chosen for a variety of wireless access point designs. As 802.11a/b/g becomes the predominant method of wireless LAN connectivity, existing access point designs are reaching their performance limits. The integration of the Intel XScale core and programmed network processing engines helps meet these increasing bandwidth requirements, while integrated interfaces including PCI, Ethernet and USB enables flexible designs with differentiating features. The provision of a dedicated hardware acceleration engine for cryptography and authentication satisfies the growing demand for security and VPN capabilities. Going forward, customer designs will require scalability to support the addition of new features. As 802.11 standards mature, including 802.11e Quality of Service, 802.11i Security, 802.11f Inter Access Point Protocol and 802.11h DFS/TPC, many customers will benefit from the processing headroom provided by the Intel XScale core.



Closer Look: Mini-DSLAM

the first in a planned line of processors with Intel XScale technology that is ARM* v.5TE architecture-compliant and specifically designed to address the line card control plane processing needs of a variety of communications and networking equipment, including wireless equipment such as Radio Network Controllers (RNC) and line cards for Node Bs and Base Transceiver Stations (BTS). The Intel IXC1100 control plane processor also optimizes performance and design flexibility for other applications, including scalable line interface cards for Multi-Service Access Platforms (MSAP), Multi-Service Provisioning Platforms (MSPP) in metro area networks, Multi-Service Switch (MSS) equipment at the network edge, and VoP gateways.

Control Plane Processing on the Line Card

For local heavy exception handling, the IXC1100 control processor is placed on the line card, where it can handle such tasks as signaling and connection management, messaging to the system's control blade, distributed route table management, and other distributed processing management tasks. Implementing the control plane processor on the line card brings the processing of signals and exceptions "close to the wire" to optimize data handling efficiency. Intel IXC1100 control plane processors provide the right blend of power, performance, price, footprint, software, and services in line card implementations where low power, high performance, small footprint and "endian-ness" are all important considerations. Both Intel IXC1100 control plane processors and Intel IXA network processors are big-endian, using a format for binary data in which the most significant bit (or byte) comes first in the word.

The IXC1100 control plane processor complements the control plane processing of the Intel IXA network processor, which performs tasks including simple exception handling, messaging to the line card control processor and the system control blade, doing local table updates on messages received from the control blade and performing local statistics aggregation on messages passed up to the control blade.

Advantages of Intel® XScale™ Technology

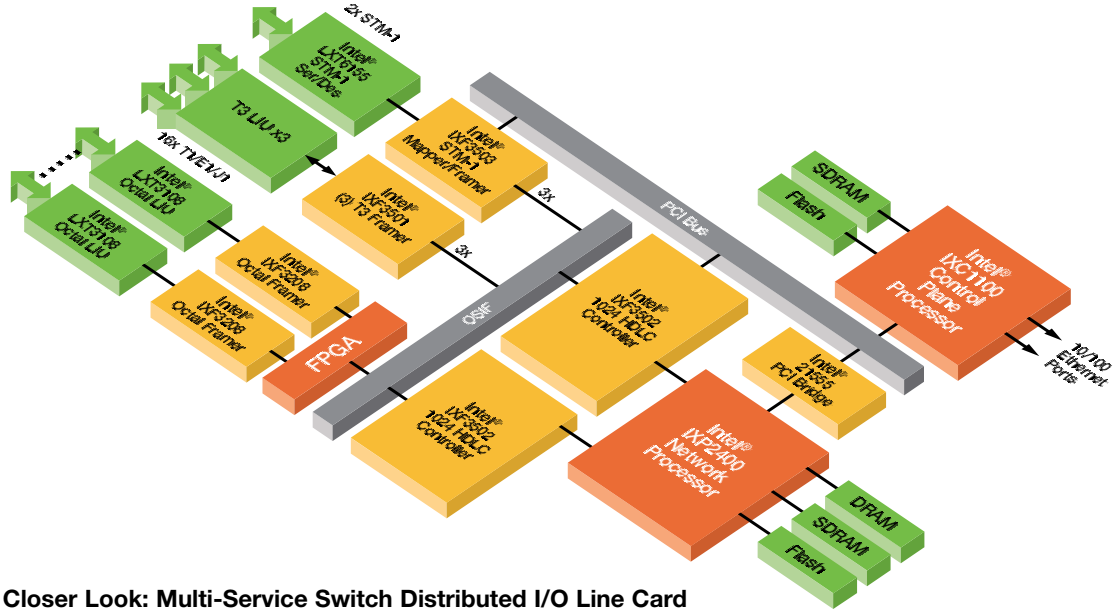
Intel IXC1100 control plane processors and Intel IXA network processors provide the most flexible choice of line card control solutions currently available to the system architect. Intel XScale technology

Closer Look: Mini-DSLAM

The Intel® IXP425 network processor for CPE and broadband access applications integrates data, voice and security functions and multiple interfaces to support a broad range of WAN and LAN technologies, including xDSL, Ethernet, wireless Ethernet (802.11x) and cable. The performance, flexibility, and scalability of the Intel IXP425 network processor have enabled the design of a flexible Mini DSL Access Multiplexer (Mini-DSLAM). The design benefits from the combination of four high-performance processing elements: the processor's Intel XScale core and three network processor engines (NPEs), which enable wire-speed performance at both the LAN and WAN ports. Because the Intel XScale core and the NPEs run their instruction streams in parallel, the Intel XScale core provides ample processing headroom. This enables the Mini-DSLAM to be a scalable design, capable of supporting differentiating product features now and additional features in the future. Since the NPEs are hard-coded devices, they accelerate time-to-market by addressing predetermined data communications functions needed in the design.

Closer Look: Multi-Service Switch Distributed I/O Line Card

An example of an IXC1100 control plane processor application is the Multi-Service Switch Distributed I/O Line Card. The design utilizes Intel® components including the IXC1100 control plane processor with two 10/100 Ethernet ports, the Intel IXP2400 network processor, the Intel® LXT3108 Line Interface Unit, IXF3502 High-level Data Link Controller (HDLC), IXF3501 T3 Framer, and both Octal T1/E1, T3 and OC-3 PHYs. The line card supports control plane software for a variety of protocols including: ATM, Frame Relay, PPPoE, PPPoA, and Border Gateway Protocol (BGP).



Closer Look: Multi-Service Switch Distributed I/O Line Card

is optimized for high performance and low power, and the use of the XScale core in both the control plane and network processors simplifies the task of software partitioning without impacting forwarding plane throughput. ARM v.5TE instruction set compliance enables developers to take advantage of the robust ARM ecosystem, including tools and software. In addition, the availability of robust Intel XScale tool chains eases design-in with future processors on Intel's control plane and network processor roadmaps.

Software and Tools

The Intel® IXCDP1100 Development Platform enables the rapid development of control plane software, and includes a hardware platform based on the IXC1100 control plane processor, compiler/debug tools and a real-time operating system board support package. The development platform also includes Intel IXC1100 Control Plane Performance Primitives for operations such as cyclical redundancy checking (CRC 7) algorithms, hash table searches, and TCP/IP checksum. Complementary software includes highly optimized strategic protocol components, as well as third-party software designed to optimize application performance and accelerate time-to-market, including evaluation copies of Wind River Tornado*, ARM Limited ADS*, and Red Hat GNUPro*.

Intel® Architecture Processors for Communications

Intel® Architecture processors, chipsets and other building blocks meet the growing requirements of applications and services processing, management and system control blades, and content processing blades. With their industry-leading processing capability, scalability, extended life cycle support, and software development environments, these processors provide a combination of performance, scalability, and upgradability for network infrastructure applications. The Intel Architecture product line includes the Intel® Xeon™ processor for the highest levels of compute performance, and the Intel Pentium M processor and Low Voltage Intel® Pentium® III processor for bladed form factors.

Applications and Services Processing

Compute-intensive applications are often at the heart of differentiated communications products and network services. Intel Architecture is the best choice to meet the demands of call control, Home/Virtual Location Register, billing management and provisioning services and may also be used to direct and manage clusters of blade-based or line card-based content processors.

Processing requirements for applications and services blades include processing density, scalable performance, and reduced power consumption, which varies by blade form factor. Intel Architecture silicon components for applications and services processing include the Low Voltage Intel Xeon processor and the Intel Pentium M processor, both coupled with the high I/O bandwidth, large memory addressing Intel® E7501 chipset. The combination of a high compute performance processor and 3 GB/s of chipset I/O bandwidth is well suited for multi-Gb Ethernet applications.

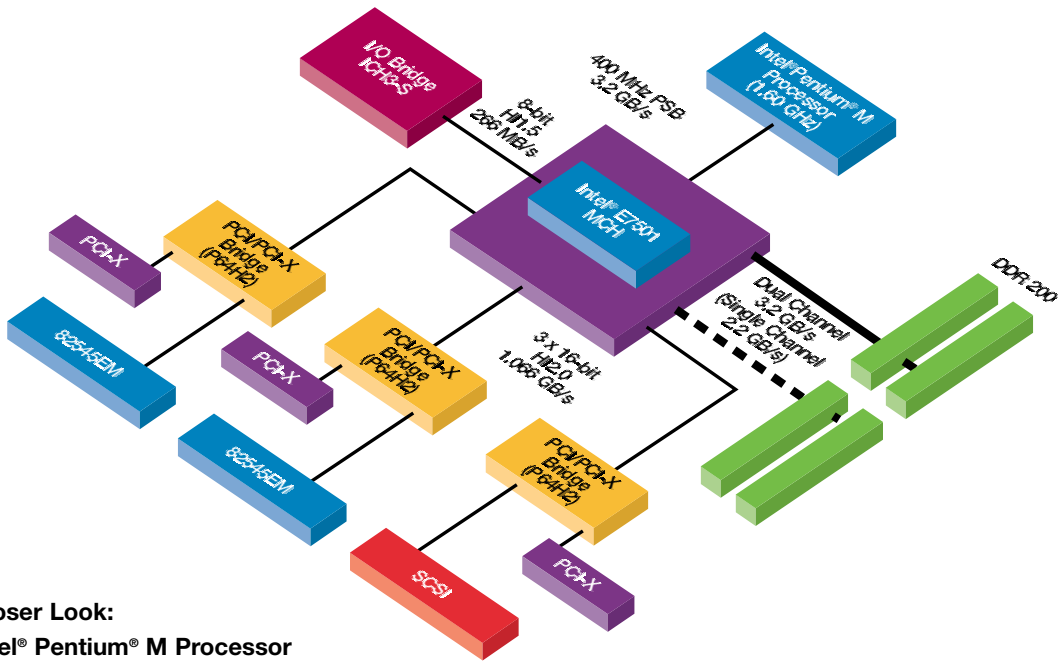
Content Processing

Content processing blades are designed to handle intensive content-based processing outside the capabilities of the standard line card for applications including voice processing, encryption offload, and intrusion-detection systems. In this communications processing space, performance demands are high, and may be satisfied by processor designs whose density provides the maximum computational horsepower within the available form factor and thermal envelope.

Intel Architecture is an excellent choice where very heavy processing on each packet is a key consideration. Intel Architecture processors for content processing include the Intel Pentium M processor with the Intel E7501 chipset and the Low Voltage Intel Pentium III processor with 512K cache and Intel® 815E chipsets. These processor-chipset combinations provide outstanding compute performance within a small bladed form factor.

Management and System Control Processing

System management functions include driver enumeration, route table management, global table management, network address translation and messaging to the control blade. Intel Architecture is most suitable in centralized control and system management blades (shelf controllers) where scalability and software flexibility is a primary consideration. Intel Architecture building blocks suited for management and system control processing include the Low Voltage Intel Pentium M processor with the Intel E7501 chipset and the Low Voltage Intel Pentium III processor with 512K cache and the Intel 815E chipset.



Closer Look: Intel® Pentium® M Processor

Closer Look: the Intel® Pentium® M Processor

The Intel Pentium M processor is micro-architected with features that are optimal for communications. It delivers the highest levels of processing performance available within a 12-25W thermal envelope. More efficient execution, power-optimized circuitry and large L1 and L2 caches enable this processor to support more complex exception-handling, without higher thermals, in compute-intensive applications that need to operate at multi-Gigabyte data rates. It also provides the fast context-switching performance to handle large numbers of concurrent connections.

The Pentium M processor is ideal for control and signaling applications including radio network controllers and media gateway controllers that need to support more services per call. Platforms based on the Pentium M processor and the Intel E7501 chipset deliver the performance, low thermal characteristics, and I/O bandwidth needed in ultra-dense communications environments. The Intel® Pentium® M Processor Communications Appliance reference design is available to accelerate designs based on the Pentium M processor and Intel E7501 chipset.

Development Tools and Software

Intel Architecture for communications also offers a comprehensive array of development tools for performance analysis, software development, and hardware integration. The easy programmability and code compatibility of Intel Architecture helps minimize time-to-market, since once their system hardware has been deployed, vendors can add differentiating features through software modifications. This platform-based approach to development maximizes the "time-in-market" for a given hardware design, and enables developers to easily implement value-added and innovative features without expensive re-engineering.

Intel Architecture for communications has a number of other important advantages for developers:

- Support for a wide range of standard and real-time operating systems
- Scalable reference designs for communications platforms
- Embedded product life cycles to further maximize time-in-market
- Low-profile packaging adapted to small form factor communications devices
- Intel® product roadmaps for a continuous, cost-effective product evolution.

Development tools and software for Intel Architecture enable developers to focus their available resources on applications and value-added services that will help sustain their competitive advantage. Intel provides building blocks that work together in specific configurations to support short time-to-market development of a variety of distributed processing implementations. Applications for these Intel® Communications Reference Designs include: load balancing, network attached storage and storage area networking equipment, network security, Virtual Private Networks, Voice over IP (VoIP), and Web caching.

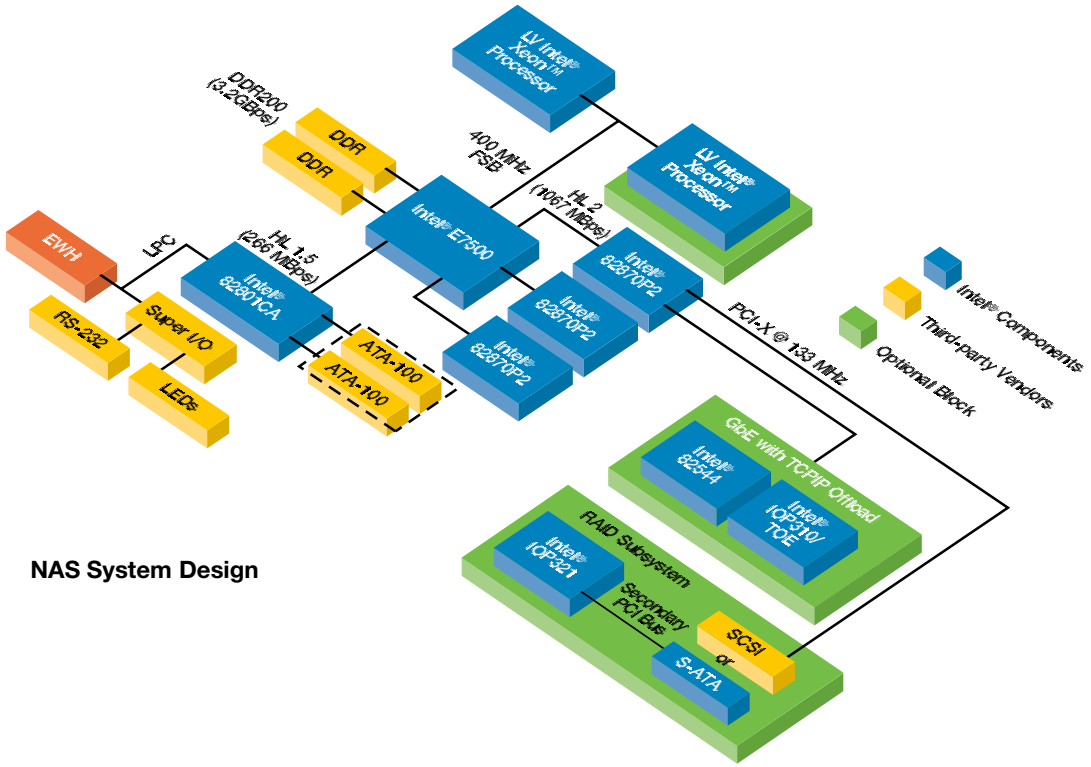
Networked Storage: Intel® I/O Processors and Intel® Architecture

The growth of Internet computing has made the I/O processor a key factor in system reliability and performance. With the introduction of the Intel® IOP321 I/O processor, Intel is building on nearly a decade of I/O processor leadership.

Enterprise servers and networked storage applications, including network attached storage (NAS) and storage area network (SAN) implementations, require high rates of I/O throughput for optimal performance. The Intel IOP321 I/O processor is a highly integrated, cost-effective I/O system-on-a-chip designed to move high quantities of data onto the wire to support I/O-intensive applications. To speed time-to-market, the Intel IOP321 I/O processor is supported by a comprehensive suite of software libraries and tools for Intel XScale technology.

The Intel IOP321 I/O processor at 400 or 600 MHz is optimized for high performance in networked storage devices, TCP/IP offload subsystems, RAID and iSCSI controllers. Reduced power consumption eliminates the need for a heat sink and its single-chip design enables developers to conserve board real estate. The processor supports the PCI-X bus and PC200 DDR SDRAM, enabling networked servers and storage devices to transfer data faster to alleviate bottlenecks and improve network storage I/O performance. Intel also provides the Intel® IQ80321 development kit, which includes resources to begin development of networked storage devices utilizing the Intel IOP321 I/O processor.

Intel Architecture processors complement Intel® I/O processors as key building blocks for storage applications. Intel Architecture processors and chipsets support high-density dual-processor platform designs with high I/O bandwidth, large memory addressability and the added reliability of ECC (error correcting code) memory support, while meeting tight space and thermal requirements.



NAS System Design

NAS and SAN

NAS is hard disk storage attached to a local area network and provided with its own IP address, rather than being directly attached to a department server. Removing disk storage and storage management from the server speeds access to applications and files because they are no longer competing for CPU resources in the server. File requests are mapped by the main server to the NAS file server. NAS includes hard disk storage, including multi-disk RAID systems and software for configuring and mapping file locations to the network-attached device.

In addition, NAS can be included within a SAN. NAS software can usually handle a number of network protocols, including Microsoft Internetwork Packet Exchange* and NetBEUI, Novell Netware Internetwork Packet Exchange*, and Sun Microsystems Network File System*. Configuration, including the setting of user access priorities, is usually possible using a Web browser.

Intel has expanded its extensive line of IA processors for storage with the introduction of the Intel® Low Voltage Xeon™ processor at 1.6 GHz. This processor delivers a combination of computational performance, density and reduced power dissipation complemented by scalability and the ability to upgrade system-level functionality in software. It also features Intel's Hyper-Threading Technology. In the NAS system design, a Low Voltage Intel Xeon processor provides the processing power to manage file requests from the network and cache data being processed while the IOP321 I/O processor handles a RAID volume containing multiple drives in a striped, mirrored or parity-based disk array.

Complementary Layer 1 and Layer 2 Silicon

By combining Intel network infrastructure processors with complementary Layer 1 and Layer 2 communications silicon, designers can create high-performance solutions optimized for specific networking and telecommunications applications in the enterprise, at the edge, and in metro and long-haul networks.

Ethernet Solutions

In the enterprise, Intel offers Ethernet solutions from 10 Mbps to 10 Gbps, with a wide range of MAC, PHY, and integrated single-chip solutions available for client, server, and storage applications. In addition, Intel produces Layer 2 and Layer 2/3/4-switching silicon for modular and stackable switches in a variety of port densities designed to reduce cost per port while delivering maximum performance. Intel's full range of SPI 4 phase-2 MACs includes the 10-port 10/100/1000-Mbps Ethernet MAC.

Layer 1 and Layer 2 Devices

At the network edge, Intel® Layer 1 and Layer 2 devices complement Intel network infrastructure processors, providing a complete traffic management solution needed to overcome bottlenecks at the access point of a channelized line card. The two-chip solution consists of a link aggregator for framing and mapping and a high-level data link control (HDLC) device to provide Layer 2 processing, analyzing incoming data and supporting multiple protocols including TDM to IP, ATM, pure IP, and traditional TDM. In addition to optimizing performance by offloading Layer 2 data link processing from the network processor, the Layer 1/ Layer 2 complementary silicon solution can eliminate the need for multiple line cards to convert traffic to T1/E1, DS3/E3, OC-3/STM-1, OC-12/STM-4, channelized down to DS-0. Intel's Layer 1 and Layer 2 devices enable a universal line card architecture to support a variety of traffic types on-demand through software changes. These Intel solutions are complete with sample code and support scalable solutions up to OC-48.

Optoelectronic Silicon and Optical Transceivers

Intel provides optoelectronic silicon for enterprise, metro, and long-haul applications. These products include CMOS physical medium dependent (PMD) devices, high-performance low-power physical medium attachment (PMA) components, framer and MAC solutions for optical transport network (OTN), SONET, 10-Gbps Ethernet and forward error correction (FEC) applications. For customers seeking greater integration, faster time-to-market, and reduced inventory costs, Intel provides a full suite of optical transceivers. Intel® optical transceivers support 300-pin, Xenpak*, and XPAK* multi-source agreements (MSAs), support single or multi-rate applications in SONET and 10-Gbps Ethernet, and provide reach to 2, 10, 12, 40, and 80 km.

Intel® Communications Software Services

Whether a developer is creating a new solution or migrating from a legacy platform, Intel® Communications Software Services (Intel® CSS) specializes in providing the resources and assistance needed to accelerate time-to-market with Intel network infrastrutcture processors. Intel CSS provides professional software development assistance at multiple levels to help developers get started fast and drive your development program to completion:

- Software building blocks and pre-assembled, validated software solution kits to help developers start fast.
- Professional software development support services, including customization, enhancement, software integration, optimization, and long-term support are available to help developers complete their designs and move products to market.

This software and service package, coupled with Intel® silicon, boards, development platforms and tools, provides a single point of contact that can help developers take optimal advantage of the performance and programmability of Intel network infrastructure processors including Intel IXA network processors, Intel IXC1100 control plane processors and Intel Architecture processors for communications.

Intel® Communications Alliance

Today's communications and embedded computing solutions are delivered by a worldwide community that uses Intel technologies, building blocks, and technical and co-marketing support services. The Intel® Communications Alliance was formed to help this community develop new opportunities for growth through active engagement with developers and solutions providers worldwide. Members include platform providers, suppliers of complementary silicon components, and vendors of software applications, operating systems, and development tools. The community provides members with the opportunity to collaborate in new ways to deliver innovative solutions in less time at lower cost, and then to pass these competitive benefits on to their customers. Intel works with community members to provide underlying communications and computing technologies and to drive the industry-standard specifications needed for greater choice, stability and opportunities for market growth.

Qualified third-party vendors provide tools and software solutions optimized to interoperate with all Intel network infrastructure processors and enable equipment manufacturers and application developers to take optimum advantage of their performance and programmability. Third-party developers provide a wide choice of operating systems, productivity tools, professional services, hardware/software tools, and software applications. Complementary silicon providers enhance development based on Intel network infrastructure processors by providing classification silicon, ternary content addressable memory (TCAM) devices, encryption silicon, bridges, switch fabrics, and other components.

Working with third-party vendors has significant benefits for Intel customers:

- **Multiple levels of integration—**Customers can buy at whatever level of integration they prefer. Choices range from combinations of processors and operating systems to highly integrated Intel® evaluation boards and development boards. Customers who desire the highest level of integration can select full system-level solutions that can include operating systems, other software applications, processing blades, I/O cards and other subsystems, in a carrier-grade NEBS or ETSI-compliant chassis.
- **Alignment with Intel technologies, initiatives, and industry standards—**Through its communications developer programs, Intel is making its network infrastructure processors available to equipment manufacturers in form factors that support modular platform form factor requirements, including the AdvancedTCA*, ATX, CompactPCI*, PrPMC, and High-Speed Mezzanine Card (HSMC) standards. Software support includes carrier-grade Linux* and other operating systems, Service Availability* middleware, and the Intel® IXA software portability framework.
- **Quality—**The large number of highly qualified companies supporting the Intel network infrastructure processor roadmap provide quality complementary silicon components, engineering expertise, rigorous quality standards, and the right tools and development software.

Software

Intel is actively engaged with leading global vendors of data plane and control plane software that is compliant with protocol standards as published by worldwide standards bodies including ITU, ETSI, ANSI, IETF, 3GPP, and others. The goal of Intel's engagement with independent third-party software vendors is to create a model for the development of leading-edge software solutions for network processing, control and content processing, residential gateway applications, and professional services that enables customers to accelerate time-to-market, and reduce cost using Intel® processors.

Data plane and control plane software components and toolkits enable communications equipment manufacturers to build products for the following applications:

- Voice-Over-Packet Networks, including SIP, H.323, MGCP, and MEGACO
- GPRS/3G/UMTS Wireless Infrastructure, including AAL2, ALCAP, RANAP, GTP, and SIGTRAN Security Solutions, including VPN and firewall applications
- Storage Solutions, including iSCSI and FSPF
- CPE/edge/core routers and gateways, including OSPF, IS-IS, MPLS, and PIM.

The Intel® IXA Portability Framework and microblock code libraries provide an easy-to-use modular programming framework that protects software investments. The portability framework enables developers to use modular, portable code blocks and integrate third-party software products for longer product life and easier maintenance, reducing time-to-market by minimizing time-consuming development of infrastructure software.

Tools

Intel Architecture and Intel XScale technology include robust development tool chains that simplify software development while meeting the diverse demands of distributed processing. The use of Intel XScale cores for Intel network processors and control plane processors enables developers to use the Intel XScale tool chain across both device categories. Board support packages for leading operating systems, compilers and debug tools simplify integration and enhance software performance and reliability. Advanced graphical programming tools from third-party vendors further ease software engineering efforts, allowing customers to focus engineering resources on product value and differentiation while reducing time-to-market.

Focusing on Total Solutions

Intel® communications developer programs are transitioning from product-enablement to broader solutions-enabling efforts within key vertical market segments. This increasing focus on vertical market development solutions includes proof-of-concept designs that demonstrate the integration of Intel network infrastructure processors with complementary modular silicon components, standards-based interfaces, drivers, and software.

Summary

Today's communications equipment must be designed from the outset to handle faster line speeds, multiple protocols, and heavier processing per-packet. At the same time, the cost-effective provisioning of revenue-generating services continues to be a top priority with service providers. Communications processing platforms must be designed to adapt to rapidly evolving requirements without wholesale hardware replacement. All of these factors help to explain why it is becoming essential to distribute increased processing intelligence "closer to the wire."

Intel continues to build upon the industry-leading programmability and performance of Intel IXA network processors and Intel Architecture processors for communications with an expanded portfolio of network infrastructure processors that make it easier for equipment manufacturers to optimally distribute high-performance processing where and when needed in modular networks. Intel's network infrastructure processors include:

- Intel IXA network processors for wire-speed packet forwarding
- Intel IXC1100 control plane processors to help meet the growing need for high-performance, low-power distributed control plane processing on the line card
- Intel Architecture processors for communications to meet the compute-intensive processing requirements of applications and services blades and content processing, in addition to systems management and control.

With optimized software, development tools, reference designs, and complementary silicon available through Intel and active third-party developer programs, Intel's network infrastructure processor families help equipment manufacturers benefit from the trend to distributed processing by providing versatile design choices to the system architect. Intel's advanced network infrastructure processors offer the high performance and functionality required to extend intelligence in the network, enabling superior design flexibility and faster time-to-market to meet the growing demand for rich network services.

Intel Access

Developer Web Site	developer.intel.com
Intel Communications Processing	http://www.intel.com/go/commsprocessing
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