

# Itanium™ Processor Overview and the IA-64 Roadmap

March 2000



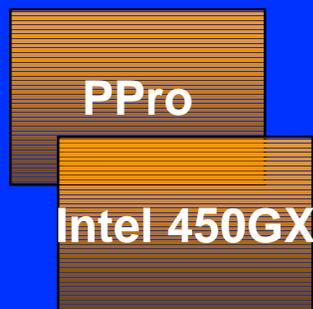
# Agenda

- **IA-64 Program Objectives**
- **Program Accomplishments**
- **Industry Development Programs**
- **IA-64 Roadmap**
- **Industry Action Plan**

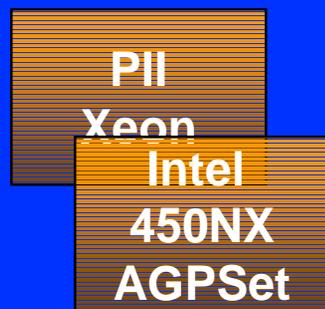
# IA-64 Architecture Mission

- **Improve upon capabilities of today's architectures**
  - New levels of parallelism for higher performance and scalability
  - World class floating-point for WS/scientific apps
  - 64 bit addressing for future Server and WS applications
- **Headroom for emerging performance intensive apps**
  - Scalable systems architecture - many processors
  - Scalable processor implementations - more powerful
  - Flexible and rich instruction set to address future needs
- **Deliver unparalleled investment protection**
  - Full binary compatibility with Intel's IA-32 instruction set in processor hardware

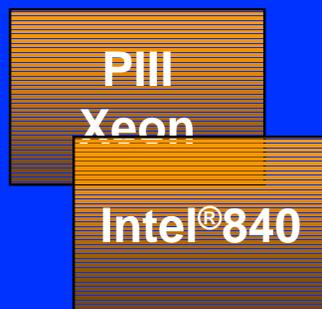
# Years of Extensive Enterprise Platform Experience



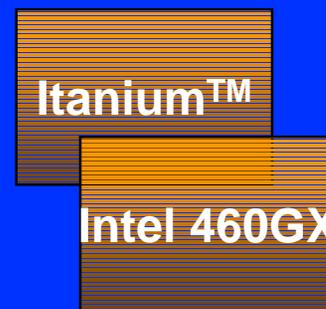
- Supports up to 4p
- 66MHz FSB
- 4GB memory support, with auto detection: BEDO, EDO w/ ECC, FPM
- 5 PCI Bus Master support + Host and PCI-ISA I/O Bridge



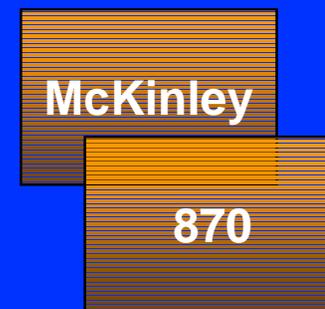
- Supports up to 4p
- 8GB memory support
- 100MHz FSB
- 100MHz EDO DRAM w/ECC support
- Supports Intel server management



- Supports up to 4p
- 133MHz FSB
- High BW Rambus Memory (3.2GB/s)
- SDRAM memory supported
- Intel accelerated Hub Architecture
- Supports 66MHz/64 bit PCI
- ECC on memory/data paths
- ACPI, SMBus, IPMI



- Supports up to 4p
- High bandwidth 2.1 GB / s FSB
- ECC on memory & data paths
- Supports MCA, Parity
- Supports Intel server management
- Memory chipkill
- Integrated PCI hot plug
- 66MHz/64 bit PCI
- ACPI, SMBus, IPMI



- Supports up to 8p
- Scalability port
- Hot plug CPU nodes
- Higher bus b/w
- PCI-X 64bit / 66MHz
- Hot Plug PC-XI & Infiniband
- Legacy I/O support
- Supports MCA, Parity
- ACPI, SMBus, IPMI
- Memory chipkill
- Fail-over through multi-pathing

**IA-64: Build upon extensive Intel platform expertise**

# e-Business Platform Requirements

## Server Segments

- Increased manageability, availability & reliability
- High degree of security for required for OLTP
- High scalability
- High Bandwidth I/O
- Headroom for unpredictable loads
- Investment protection
  - IA-32 app compatibility
- Strong partnerships solutions
  - OEMs, OSVs, ISVs, IHVs

## Workstation Segments

- Scalability
- Effective data bandwidth
- Larger data-set management
- Excellent floating point performance
- Binary compatibility with 32-bit instruction set

# The Itanium™ Processor Platform

- Architectural headroom to deliver the performance and scalability for the next 25 years
- Designed to deliver availability, performance and scalability for enterprise and technical applications
- Unparalleled industry commitment across a broad range of hardware and software stacks
- IA-64 complements IA-32 to deliver a complete range of server & workstation solutions for the industry

*The essential ingredients are in place*

# Agenda

- IA-64 Program Objectives
- **Program Accomplishments**
- Industry Development Programs
- IA-64 Roadmap
- Industry Action Plan

# Progress Since First Itanium™ Silicon



August '99

- First samples available
- 460GX chipset sampling
- First demo running Windows-64 and Linux
- Compiler focused on functionality
- OSVs porting drivers, shipping SDKs on simulator
- Key apps running on simulator

March '00

- Itanium™ processor prototype systems delivered in thousands
- Systems from top OEMs powered on and demonstrated
- Six major operating systems running on hardware
- Compilers focused on optimization
- Applications development on hardware
- Key network, video and other drivers running on platform

***Great progress toward solutions in 2H '00***

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# Hardware / Software Public Events

- **August: Operating system demos on simulator**
- **September: First Public Itanium™ processor demo**
  - Graphics demo on Win64
  - Linux platform running Apache Server
- **October: First e-Business demo**
  - Microsoft Internet Information Server (IIS)
  - Secure transaction processing via Open SSL encryption
  - 3-D Rendering, OpenGL
- **November / December: Major applications running**
  - Oracle 8i on Win64 and HP-UX
  - Four system cluster running supercomputing application
  - NEC 16P capable system demo runs SQL Server
- **January / February: First performance highlights**
  - Tremendous security performance on RSA decrypts
  - Trillian IA-64 Linux released and demonstrating IA-32 compatibility and high-end graphics

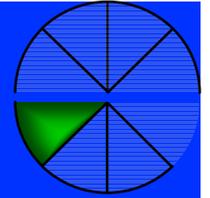
***Spring '00 IDF: SMP and 8 OEM Demos***

# Significant IDF'00 Announcements

- **Public release of IA-64 S/W information and tools**
  - IA-64 Software Developers Manual
  - Software Conventions & Application Binary Interface
  - System abstraction Layer (SAL)
  - Assembly Language Reference Guide
  - Floating Point libraries
- **Public release of Linux development tools**
- **First public SMP demo**
- **Demo suite highlighting systems from 8 OEMs**
  - Server applications: databases, data mining, ERP ...
  - Workstation applications: DCC, EDA, fluid dynamics ...
- **Presentations by SGI, HP, IBM, Microsoft, Oracle, Red Hat, VA Linux, and other major IA-64 vendors**

*Full Development Support: from  
Firmware to Applications*

# Itanium™ Processor

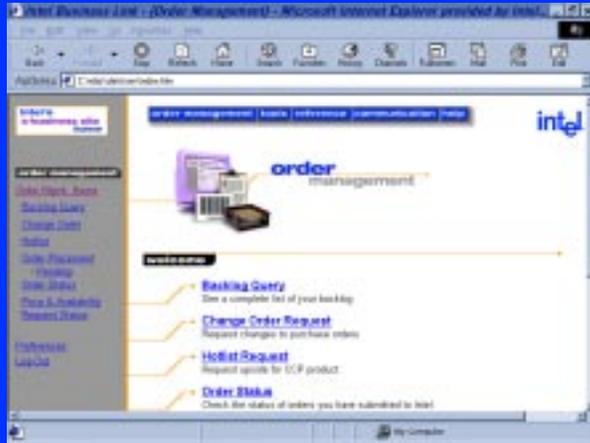


- **800 MHz production frequency**
  - EPIC enables up to 20 operations per clock
- **4 MB high speed on-cartridge L3 cache**
- **Over 320M transistors**
  - 25M in CPU, 295M in L3 cache
- **2.1 GB/s multi-drop system bus**
  - Enhanced Defer Mechanism enables high scalability through improved bus efficiency
- **Extensive reliability and availability**
  - ECC, parity protection, enhanced MCA
- **Excellent functionality on initial silicon**
  - No architectural or ISA changes required
  - MP functionality on track to plan



*Tuning / testing for production this year*

# e-Business Application Benefits



- ✓ Data Warehousing / Decision support
- ✓ In memory databases
- ✓ On-line transaction processing & on-line analytical processing
- ✓ Enterprise resource planning
- ✓ Customer relationship management

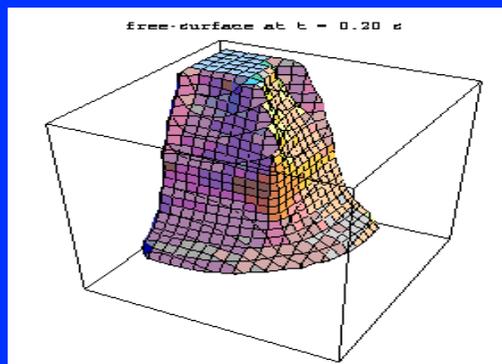
## System Benefits

- Larger databases and more users supported on a single system
- Greater responsiveness
- High multiprocessor scalability
- Improved availability
- Enhanced manageability
- Security performance
- Object oriented code performance (Java, C++)

## Itanium™ Processor Features

- EPIC: Predication, speculation
- Large cache w/ cache hints
- Large memory support with 64-bit addressing
- Double bit ECC with on-the-fly correction of single bit errors
- Enhanced Machine Check Architecture
- Intel Server Management support
- Fused multiply-add instruction
- Register stack & save engine

# Scientific Analysis Benefits



- ✓ Linear programming / planning & optimization
- ✓ Physics modeling
- ✓ Financial models
- ✓ Scientific R&D
- ✓ Finite element analysis

## System Benefits

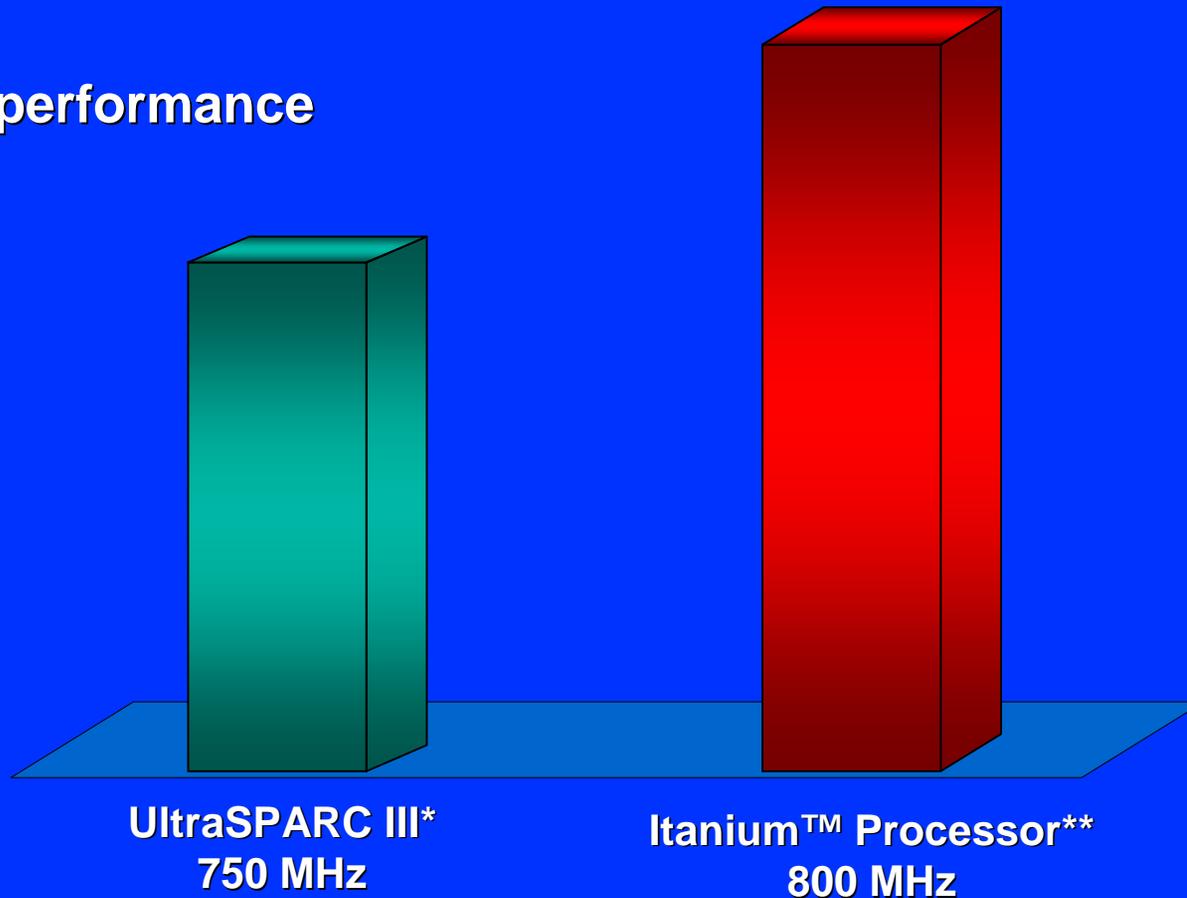
- High scalability
- Industry leading floating point performance
- Extra precise computations for very large problems
- Manage large datasets

## Itanium™ Processor Features

- High bandwidth bus
- Enhancements for MP
- Est over 2 GFLOPs on Linpack 1000
- 82 bit floating point
- 128 Integer & 128 FP registers
- Rotating registers for loop pipelining
- Large caches w/ control and cache hints
- Large memory support with 64-bit addressing

# 2H'00 Performance Landscape: Transaction Processing

Relative performance



Source : Data projections based on Intel estimates, [www.tpc.org](http://www.tpc.org), [www.spec.org](http://www.spec.org)

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, reference [www.intel.com/procs/perf/limits.htm](http://www.intel.com/procs/perf/limits.htm) or call (U.S.) 1-800-628-8686 or 1-916-356-3104

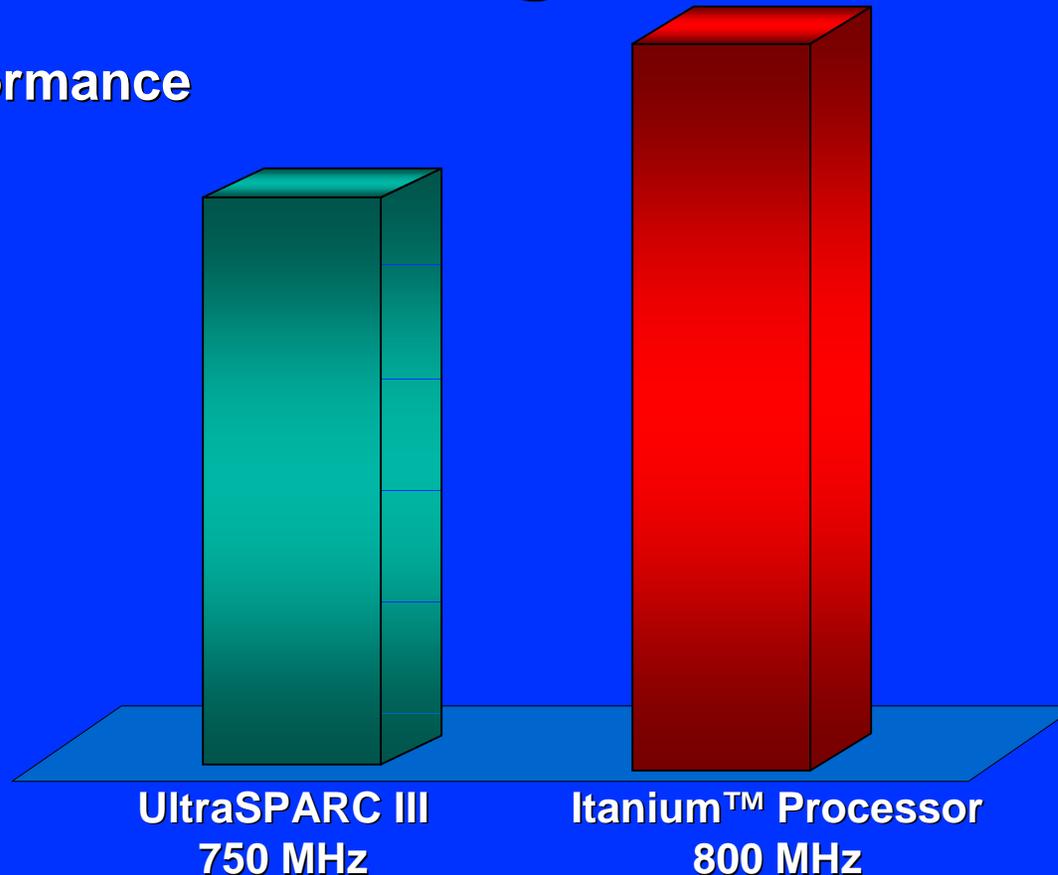
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Assumes no platform constraints, \* 4 processor systems, \*\* 4 processors, 4ML3, NT OS, SQL 7.5

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# 2H'00 Performance Landscape: Floating Point

Relative Performance



***World Class Floating Point Performance***

Source : Data projections based on Intel estimates, [www.tpc.org](http://www.tpc.org), [www.spec.org](http://www.spec.org)

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, reference [www.intel.com/procs/perf/limits.htm](http://www.intel.com/procs/perf/limits.htm) or call (U.S.) 1-800-628-8686 or 1-916-356-3104

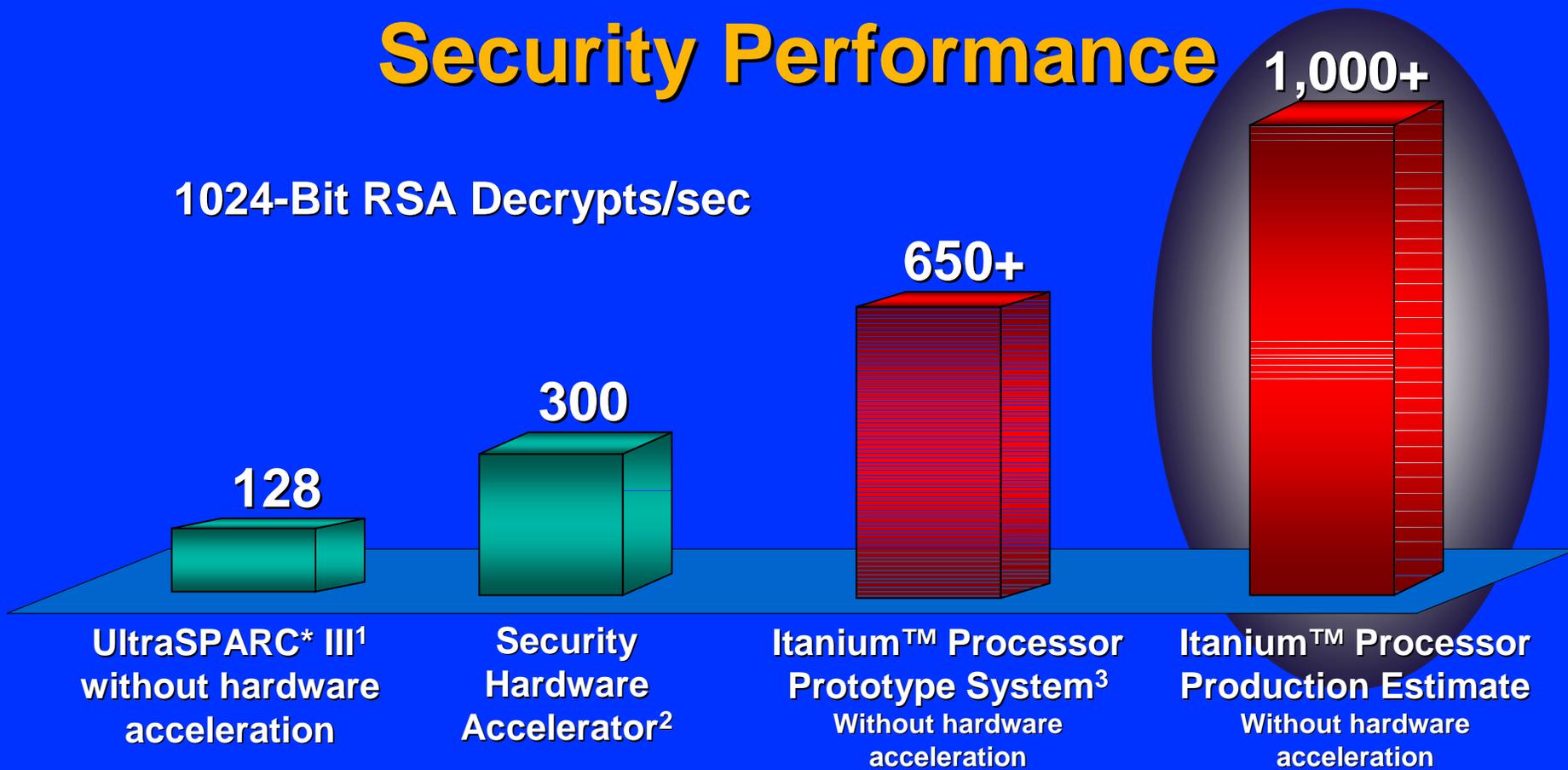
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Assumes no platform constraints

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# Itanium™ Processor Security Performance

1024-Bit RSA Decrypts/sec



**Breakthrough performance for secure transactions**

<sup>1</sup>UltraSPARC number is based on Intel theoretical analysis

<sup>2</sup>Data from [www.ncipher.com/products/files/nfastkey.html](http://www.ncipher.com/products/files/nfastkey.html)

<sup>3</sup>Performance measured on 500-600 MHz Itanium processor based server prototype engineering system

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, reference [www.intel.com/procs/perf/limits.htm](http://www.intel.com/procs/perf/limits.htm) or call (U.S.) 1-800-628-8686 or 1-916-356-3104 • Assumes no platform constraints

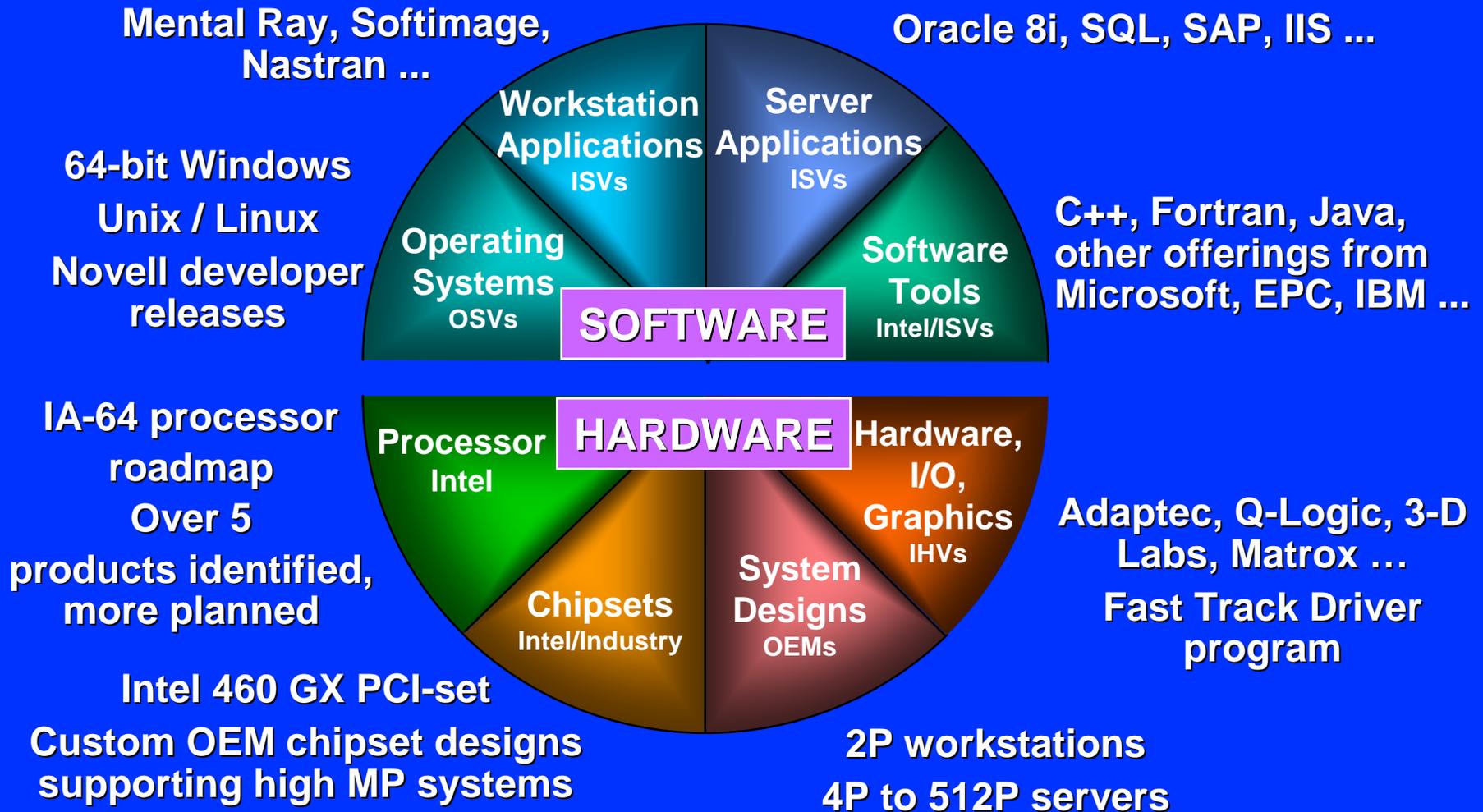
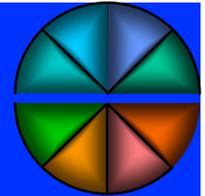
• 1T 4 processor, 4ML3, NT Spec 7.5

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# Agenda

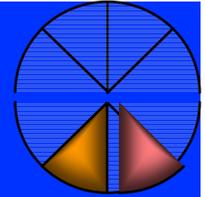
- IA-64 Program Objectives
- Program Accomplishments
- **Industry Development Programs**
- IA-64 Roadmap
- Industry Action Plans

# IA-64 Platform Readiness Program



***Itanium™ Processor Based solutions in 2H'00***

# Itanium™ Processor Systems

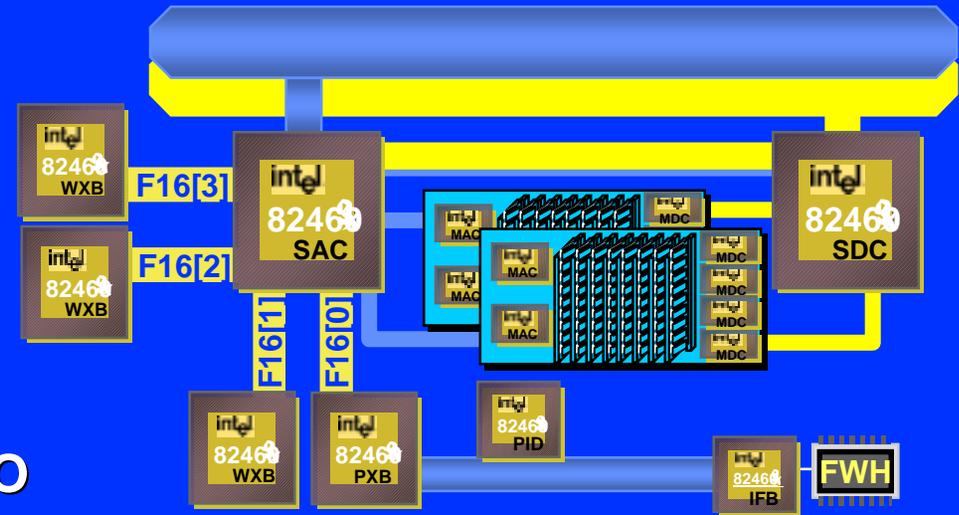


- Intel 460GX Chipset

- Support for 1-4 processors
- Dual memory ports
  - 4.2 GB/s
  - Up to 64 GB SDRAM
- 64b / 66MHz PCI Hot Plug I/O
- Extensive ECC, parity protection to complement processor
- Full functionality in MP environment with engineering samples

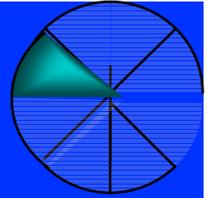
- Over 30 OEM system products

- Multiple custom high performance chipsets
- Over five 8 processor and greater system designs
- Multiple OEM designs powered up in 2H '99



***Broad base of systems in development***

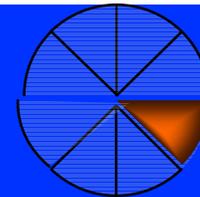
# IA-64 Operating Systems



- Microsoft (Win64)
  - Extensive functionality: Networking, TCP/ IP, Winsock, DHCP, FTP ...
  - DRG 64-bit Windows Development Labs up and running
  - Beta release Q2 '00
- IA-64 Linux (Trillian Project)
  - Full source released at Linuxworld
  - Solid functionality: glibc, IA-32 support, Apache, X-Windows, Gimp
  - Linux distributors engaged: Red Hat, SuSe, Caldera, Turbo-Linux
  - Cygnus GNU Pro tools released
- IBM, SCO (Monterey/64)
  - Wide range of platform support
  - Excellent progress on MP
  - ISV & OEM councils formed
- Hewlett Packard (HP-UX)
  - OS & Basic utilities running
  - Key device drivers ported
    - Mouse, Video, Disk, NIC
  - Oracle 8i running
- Novell (Modesto)
  - Novell Internet Caching system running on Modesto

**Key OSs approaching Beta Release**

# Fast Track IHV Program



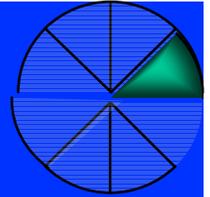
- **Simplifies and speeds porting/optimizing of device drivers to IA-64 for IHVs.**
  - Dedicated support assigned for IHVs
  - Hands-on training for SDVs / SDKs / DDKs
  - SDVs for on-site development
  - Access to Itanium™ processor technical documentation
  - Plug-fests to validate drivers on multiple OS & OEM platforms
  - Joint marketing for devices with optimized drivers
- **Graphics, Storage, Networking/Comm., Printer, Video, Audio, Clustering**
- **Over 50 IHVs engaged to date**

***Key Device Drivers in place - more on the way***

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# SW Tools for IA-64 Platforms



## Compilers

- C, C++, Fortran, COBOL

## Source Code / Version Control

- PVCS, RCS, CVS, MKS Source Integrity

## Editors

- Premia, EMACS, VI, etc.

## Scripting Languages

- TCL/Tk, PERL, PYTHON

## Test Products

- Mercury Interactive, Rational Performance Studio

## QA Tools

- Rational Quantify

## Modeling Tools

- Rational Rose

## Configuration Management

- Rational ClearQuest

## Debug Tools

- Rational Purify, Geodesic

## Test Coverage Tools

- Rational PureCoverage

## Performance Analysis Tools

- VTune

## Middleware

- IONA, Tibco

## Developer Utilities

- MKS Toolkit, Perforce

## Libraries

- Roguewave, NAG, Visual Numerics, Microquill, JPEG pro, etc.

## Migration and conversion tools

- Relativity

## License Managers

- Globetrotter, Rainbow, LUM

## Java

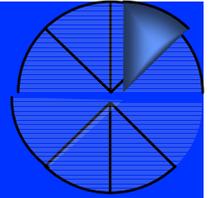
- JVM, JIT, JDK

## Other

- Sendmail, Sleepycat, Installshield, etc.

***Extensive Progress on S/W Infrastructure***

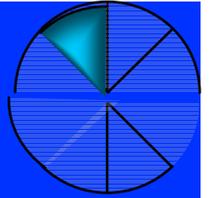
# Initial IA-64 Server Application Targets



- **Business Intelligence**
  - IBM Int. Miner
  - SAS Systems
  - Brokat Twister
- **Databases**
  - MS SQL Server
  - IBM DB2
  - Oracle 8i
  - TimesTen (IMDB)
- **ERP/SCM/CRM**
  - SAP R/3 & MySAP
  - SAP APO
- **Security**
  - RSA CryptoC
  - Checkpoint Firewall
  - Secure Computing
  - Symantec Norton Anti-Virus
- **Cache/Web Server**
  - MS IIS
  - Apache
  - Inktomi Traffic Server
  - Novell ICS
- **CRM-Call Center**
  - Aspect
- **E-Commerce**
  - Intershop
  - Broadvision
  - Selectica
- **E-Com Development**
  - MS SiteServer  
(Commerce Server)
- **Middleware**
  - Persistence EJB
- **Directory Servers**
  - MS Active Directory
  - Novell NDS
- **System Management**
  - CA Unicenter

*Top ISVs engaged and executing*

# Baseline IA-64 Workstation and Technical Computing Application Targets



## MDA

Pro/E

Catia

Unigraphics

SDRC/I-Deas

Rubicon

## DCC

Alias|W Maya

AVID/ SI 3D

3D Studio Max

NewTek LW

SynaFlex

Dante

## EDA

Calibre

Monterey Dolphin

Design Compiler

Synopsys

## Finance

RiskManager

Total Risk

Panorama

## GEO/SCI

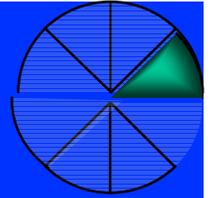
ESRI ArcInfo

Fluent

MSI/DMOL

*Leading workstation ISVs committed*

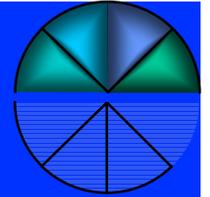
# Itanium™ Processor Prototype Software Engineering Systems



- **Over 2,000 systems delivered since first silicon**
  - Several thousand more to be delivered in 1H '00
  - 1-4 processors running at frequencies comparable to today's production servers
  - Focused on S/W development and test
- **Delivered with supporting tools and training**
  - OSV SDKs, Pre-loaded OS's. 1-800 support
- **Extends and accelerates software development through ASCs, web farm, seed systems, end user porting centers**

*Intel's largest prototype system deployment ever*

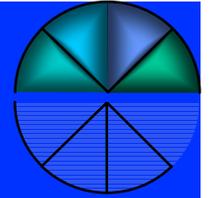
# Intel® 64 Fund



- **\$250M fund to accelerate adoption of IA-64 architecture**
  - Intel + 5 major OEMs
  - Along with 14 Global 2000 vertical segment leaders
    - Ford, GE, Boeing, Morgan Stanley Dean Witter, B of A...
- **20 significant equity investments to date**
  - Open source application server software
  - Workstation based visual query and analysis software
  - CORBA based middle-ware solutions
  - Java translation tools
- **ISV and Developer Benefits**
  - Technical support and equipment from Intel and OEMs
  - A direct path to IT organizations of major corporations
  - A network of leading edge solution providers for IA-64

*Investments accelerating in '00*

# Application Solution Centers



**ASC Worldwide Infrastructure in place:  
IA-64 capability expanding Q1 & Q2 '00**

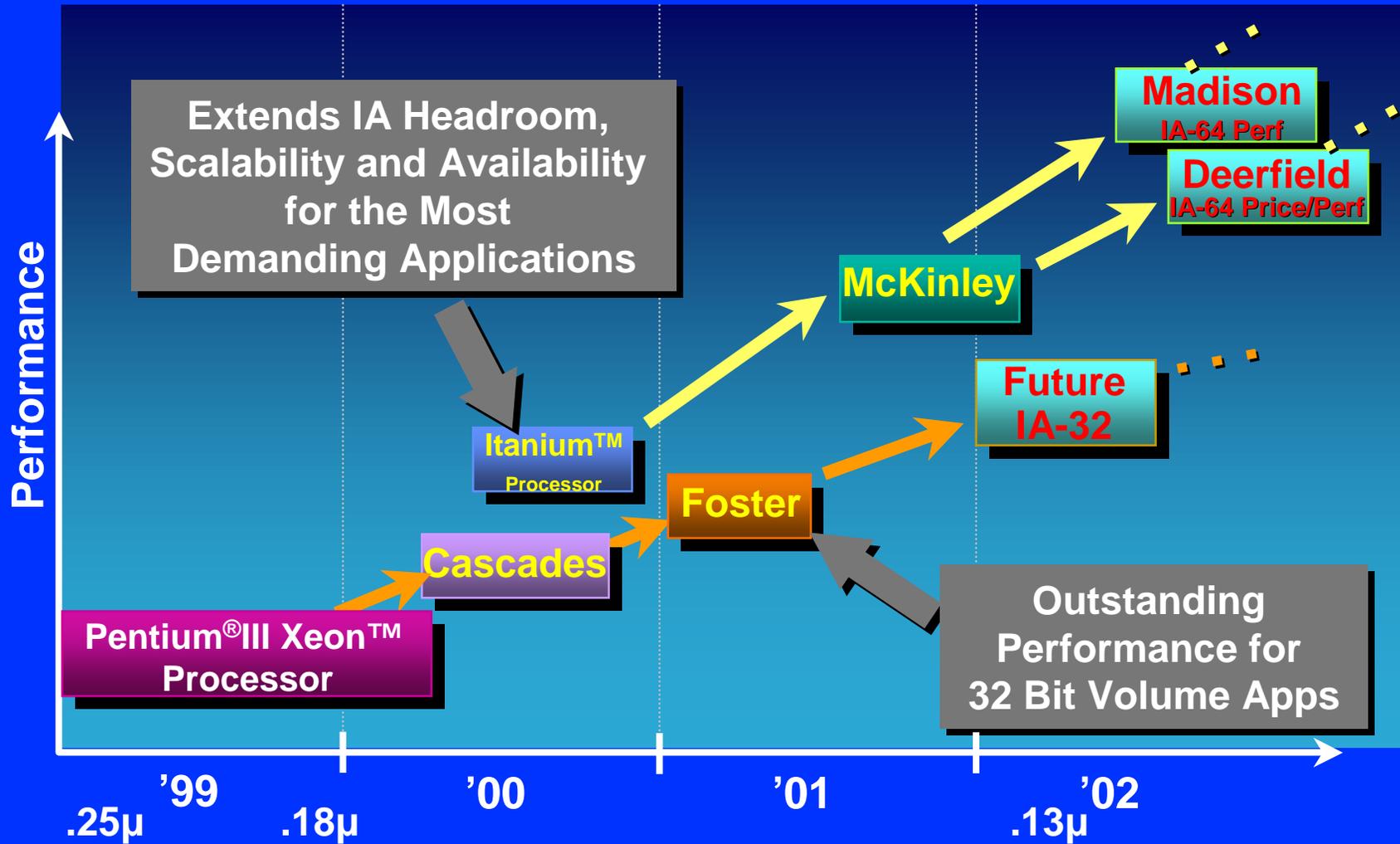
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# IA-64 Processor Roadmap



***Strong execution the first IA-64 processor, more on the way***

# McKinley Processor

## Key Features

- **Enhanced Itanium™ processor micro-architecture and system bus**
  - Fully binary compatible with Itanium™ processor
  - Expanded resources including more load/store ports and ALUs
  - On-die L3 cache
- **Builds upon Itanium™ processor infrastructure**
  - Reuses key technologies: bus protocols, power delivery technology, software tools, other key platform components
- **Continued focus on high availability for e-business**
  - Extensive error detection & correction
  - System management bus with on-package power thermal management
- **Production target: end of 2001**

***Extends IA-64 capability for end '01 timeframe***

# Madison IA-64 Processor

- Next generation IA-64 processor on .13 $\mu$  process technology
- Significant increase in frequency - beyond GHz
- Larger on-die L3 cache
- Platform compatible with McKinley
  - Intel® 870 Chipset supports Madison
- Fully S/W binary compatible with Itanium™ processor and McKinley
- Production target: mid-2002

*IA-64 Delivers Scalable Performance and Technology*

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# Itanium™ Processor Industry Commitments

<u>OEMs</u>	<u>Third Party Vendors</u>	<u>Operating System Vendors</u>	<u>Software Tools</u>	<u>Workstation Software Vendors</u>	<u>Enterprise Software Vendors</u>
<ul style="list-style-type: none"> <li>• Bull</li> <li>• Compaq</li> <li>• Data General</li> <li>• Dell</li> <li>• Fujitsu</li> <li>• HP</li> <li>• Hitachi</li> <li>• IBM</li> <li>• Integrgraph</li> <li>• NCR</li> <li>• NEC</li> <li>• IBM NUMA-Q</li> <li>• SGI</li> <li>• Siemens</li> <li>• Unisys</li> </ul>	<ul style="list-style-type: none"> <li>• Adaptec</li> <li>• American Arium</li> <li>• AMI</li> <li>• ATI Technologies</li> <li>• Data General</li> <li>• Emulex</li> <li>• Evans &amp; Sutherland</li> <li>• HP</li> <li>• LSI Logic</li> <li>• Matrox</li> <li>• Mylex</li> <li>• Phoenix</li> <li>• Q-logic</li> <li>• 3D Labs</li> </ul>	<ul style="list-style-type: none"> <li>• HP</li> <li>• IBM/SCO</li> <li>• Microsoft</li> <li>• Novell</li> <li>• VA Linux Systems</li> </ul>	<p><u>Compilers:</u></p> <ul style="list-style-type: none"> <li>• Compaq</li> <li>• Cygnus</li> <li>• EPC</li> <li>• Fujitsu</li> <li>• IBM</li> <li>• Microsoft</li> <li>• Novell</li> <li>• PGI</li> <li>• PSI</li> </ul> <p><u>Inf. Tools</u></p> <ul style="list-style-type: none"> <li>• Hummingbird</li> <li>• MKS</li> <li>• Rational</li> <li>• Roguewave</li> <li>• Softway</li> <li>• NAG</li> </ul>	<ul style="list-style-type: none"> <li>• Adobe</li> <li>• Avid</li> <li>• Cadence</li> <li>• MSC</li> <li>• Mental Images</li> <li>• Mentor Graphics</li> <li>• Parametric</li> <li>• Softimage</li> <li>• Synopsys</li> <li>• Unigraphics</li> </ul>	<ul style="list-style-type: none"> <li>• Ariba</li> <li>• Baan</li> <li>• IBM</li> <li>• Informix</li> <li>• Microsoft</li> <li>• Nuance</li> <li>• Oracle</li> <li>• PeopleSoft</li> <li>• Persistence</li> <li>• SAP</li> <li>• SAS</li> <li>• Softway</li> <li>• SpeechWorks</li> <li>• TimesTen</li> <li>• Torrent</li> <li>• Weblogic</li> </ul>

***The list keeps growing....***

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# '00 Industry Action Plan

- **OEMs**
  - Complete platform engineering testing of Itanium™ processor samples
  - Begin product qualification of production systems starting Q2
  - Plan now for McKinley for end' 01 production
- **OSVs**
  - Deliver Beta releases of OS, SDKs, and DDKs to ISVs, IHVs, and OEMs
  - Continue multiprocessing support stress testing
  - Expand device driver support
- **ISVs**
  - Get the latest releases of IA-64 tools
  - Port and optimize applications for Itanium processor for FCS in 2h'00
- **IHVs**
  - Port and optimize drivers; support pre-production plug-fests

*Be a leader in the Internet economy, be  
ready for the Itanium™ Processor this year*