IA-64 Program Overview

Ronald E Curry

Director of Marketing

IA-64 Processor Division

Intel Corporation
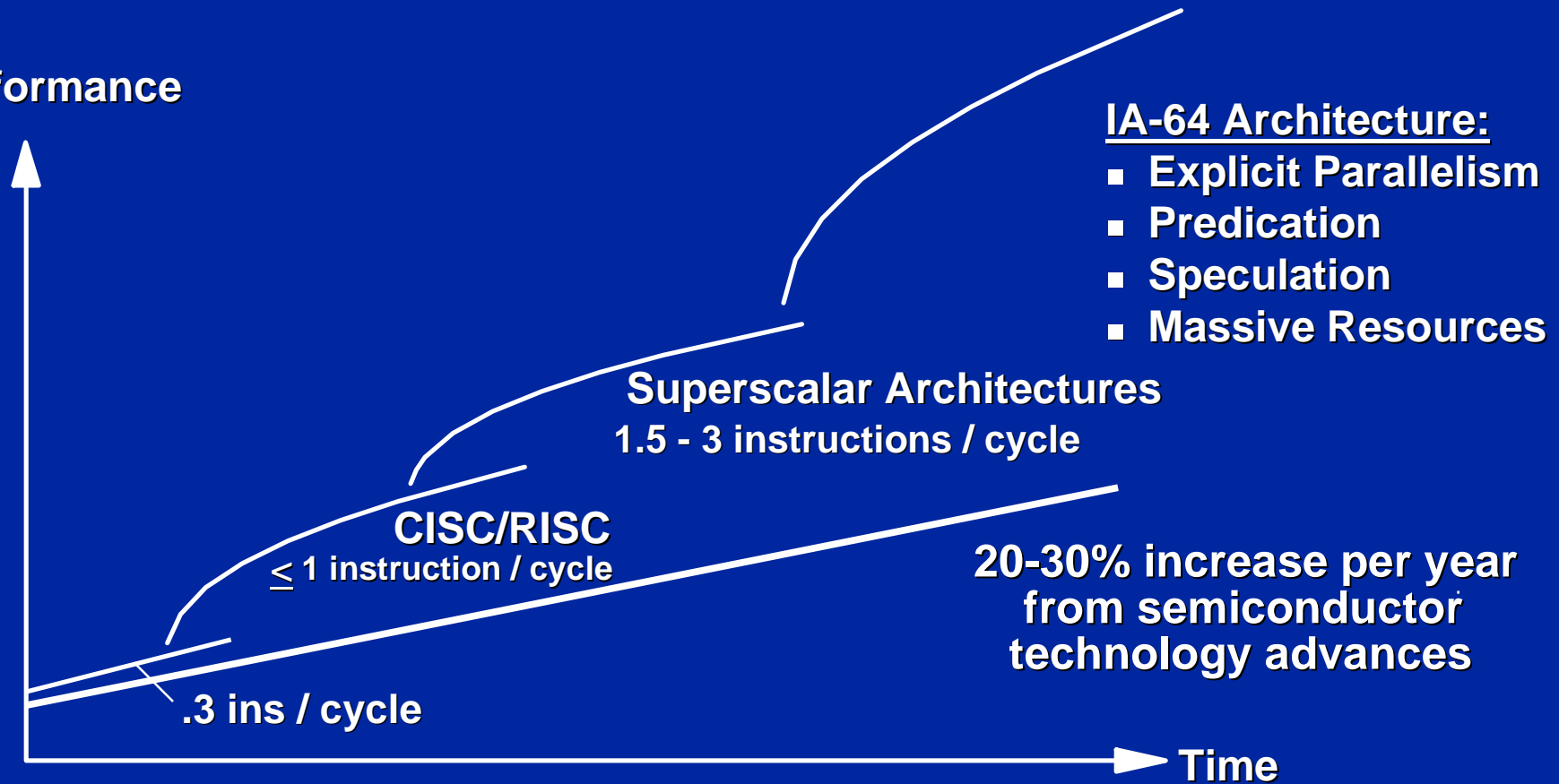
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Agenda

- **The IA-64 Opportunity**

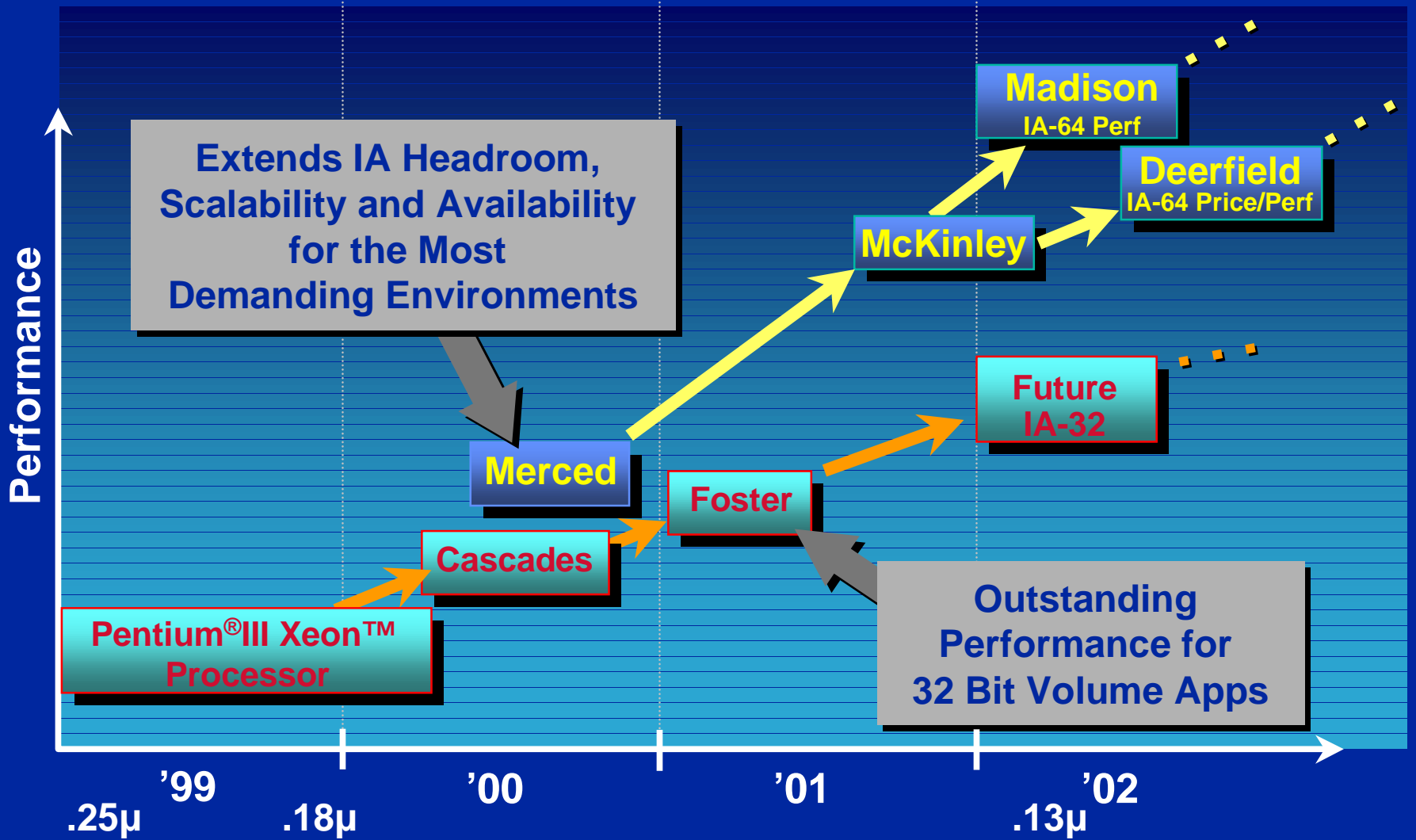- **IA-64 Program Update**

- **Get Started on IA-64 Today**

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IA-64 Next Generation Architecture

Performance

IA-64 Architecture:
- Explicit Parallelism
- Predication
- Speculation
- Massive Resources

Superscalar Architectures
1.5 - 3 instructions / cycle

CISC/RISC
$\leq$ 1 instruction / cycle

20-30% increase per year from semiconductor technology advances

.3 ins / cycle

Time

Greater room for growth than traditional architectures

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IA Server and Workstation Roadmap

Performance

Madison
IA-64 Perf

Deerfield
IA-64 Price/Perf

McKinley

Extends IA Headroom, Scalability and Availability for the Most Demanding Environments

Future IA-32

Merced

Foster

Cascades

Pentium®III Xeon™ Processor

Outstanding Performance for 32 Bit Volume Apps

'99   '00   '01   '02

.25µ   .18µ   .13µ

Performance, Price/Performance, Scalability, Availability, Compatibility

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Merced Public Commitments

OEMs

- Bull
- Compaq
- Data General
- Dell
- Fujitsu
- HP
- Hitachi
- IBM
- NCR
- NEC
- Sequent
- SGI
- Siemens
- Unisys

Third Party Vendors

- Adaptec
- American Arium
- AMI
- ATI Technologies
- Data General
- Emulex
- Evans & Sutherland
- HP
- LSI Logic
- Matrox
- Mylex
- Phoenix
- Q-logic
- 3D Labs

Operating System Vendors

- Compaq
- HP
- IBM/SCO
- Microsoft
- Novell
- Sun
- Linux

Software Tools & Inf. Vendors

- EPC
- Hummingbird
- IBM
- MetaWare
- Microsoft
- NAG
- PGI
- SCO
- Sun
- Viewlogic

Workstation Software Vendors

- Adobe
- Avid
- Cadence
- MSC
- Mental Images
- Mentor Graphics
- Parametric
- Softimage
- Synopsys

Enterprise Software Vendors

- Ariba
- Baan
- IBM
- Informix
- Microsoft
- Nuance
- Open Market
- Oracle
- PeopleSoft
- Persistence
- SAP
- SAS
- Softway
- SpeechWorks
- TimesTen
- Torrent
- Weblogic

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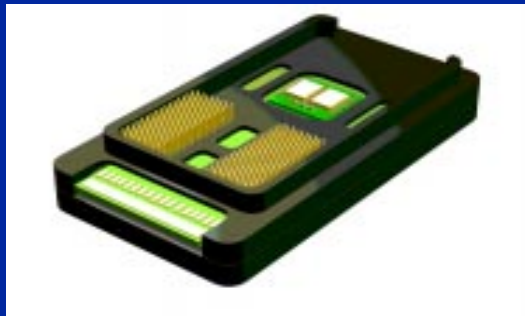
Best in class solutions from the leading vendors

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OEM Merced Commitments

- **"Compaq is committed to be among the lead vendors offering Merced based IA64 solutions to our Enterprise and Workstation customers."**
  - ◆ Mary McDowell, Vice President & General Manager, Compaq Corporation

- **"Fujitsu is developing highly differentiated IA-64 based systems with Merced as well as its successors for mission critical environments and will provide the best enterprise solutions for customers"**
  - ◆ Masahiro Kawakatsu, GM, Computer Systems Division II, Fujitsu

- **"HP's commitment to deliver Merced-based servers affords the developer's community a robust platform for enterprise solutions."**
  - ◆ Barbara Braum, R&D Manager, Hewlett Packard

- **"Hitachi will launch Merced server systems, including 8way and higher systems, for the emerging Internet business market,"**
  - ◆ Toshihiko Odaka, Senior Vice President and Director, President & Chief Executive Officer, Information & Telecommunication Systems, Hitachi, Ltd.

- **"As a strategic business partner with Intel, IBM is committed to enterprise-class IA-64 servers. Delivered concurrent with Merced, these systems will exploit progressive processor technologies, industry-leading OS, and IBM Netfinity X-architecture innovations."**
  - ◆ Randy Groves, Vice President of Netfinity Product Development, IBM Corp.

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OEM Merced Commitments

- "**NEC** is developing an original chipset to support scalable 16-way Merced processors SMP (64GB memory), large I/O with up to 128 PCI slots, and advanced RAS features."

  ◆ Kazuhiko Kobayashi, Associate Senior VP, NEC Corporation

- "**Sequent** is building scalable, high availability, Merced processor based NUMA systems designed to deliver Project Monterey's UNIX platform for IA-64 to support the world's largest enterprises."

  ◆ Jeff Pancottine, Vice President of Marketing, Sequent Computer Systems, Inc.

- "**SGI** is committed to delivering modular, Terabyte+ shared physical memory, Linux OS systems in 2000, scaling from 2 to 512 Merced CPUs."

  ◆ Jan Silverman, VP of Marketing, Computer Systems Business Unit, SGI

- "**Siemens** will support its customers to deploy their corporate IT infrastructure on market standard servers based on Merced and future IA-64 processors"

  ◆ Robert Hoog; President, Computer Systems; Siemens Computer Systems

- "**Unisys** CMP is a breakthrough technology that provides mainframe-class scalability, Merced and Xeon coexistence in the same server, partitioning, and a shared-everything design."

  ◆ Dave Houseman, VP, Advanced Technology, Unisys Corporation

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Massive Investment for IA-64 Success

- **Investment in processor technology**
  - ◆ 5 IA-64 processors currently in development and definition
  - ◆ Hundreds of experienced design engineers across IA-64 projects
  - ◆ Dedicated compiler and software tools teams

- **Investment in platform technology**
  - ◆ Intel and OEM chipsets designed concurrent with Merced product
  - ◆ Intel IA-64 server and workstation platforms
  - ◆ "Big Iron" OEM platforms ready for first Merced samples
  - ◆ 4 - 4000 processor OEM platforms

- **Investment for complete IA-64 solutions**
  - ◆ $250M Venture Fund with $100M investment from Intel, OEMs & IT
  - ◆ Millions of dollars in additional equity and NRE investments by Intel
  - ◆ Resource ramp-up targeted at industry software optimization

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Merced Launch Starts Now

- **Increased resources on software enabling**
  - Adding hundreds of people to Intel's software enabling programs
  - Increased focus on ASC and IT programs

- **Ramping IT campaign**
  - Strong IA-64 component to Intel's E-business vision
  - Major focus on CIO, CEO, CTO for IA-64
  - Seed system program planned for IT evaluation in 1H '00

- **Public rollout of Merced product/technology**
  - Application Developers Architecture Guide released in June
  - Three days of content at Intel Developers Forum (8/31-9/2)
  - Expect many demos at Industry events this year
  - Major technology/info disclosures through 2H '99 and into '00
    - Specific focus on Merced platforms and software development

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Agenda

- **The IA-64 Opportunity**

- **IA-64 Program Update**

- **Get Started on IA-64 Today**

  - ◆ **Attend the IA-64 Track to learn how**

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Merced Program Progress

- **Last IDF (Feb '99):**
  - ◆ Merced processor design on track
  - ◆ Intel® 82460GX PCIset design complete
  - ◆ OEM system designs complete
  - ◆ Compilers meeting performance targets
  - ◆ Operating systems running on simulator
  - ◆ ISVs actively porting applications
  - ◆ IHVs actively porting drivers

- **Today:**
  - ◆ Merced processor in fabrication, samples underway
  - ◆ Intel® 460GX PCIset components sampling
  - ◆ OEM systems ready for first samples
  - ◆ Compiler focus now on productization
  - ◆ OSVs porting drivers, shipping development kits
  - ◆ Key applications running on simulator, ready for systems
  - ◆ Drivers ready for first systems

Focus shifting from pre-silicon development to prototype debug and production ramp

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Merced Program Convergence

- **Merced processor first silicon received - excellent progress**

- **Delivery of engineering samples to OEM's has begun**

- **Intel® 460GX PCIset sampling now**

- **Many OEM systems ready for initial samples**

- **All OS's running on Merced simulator and working on bring-up and test**

- **Major applications running on Merced simulator and ready starting initial silicon testing**

- **Key drivers for major OS's in place**

All elements in place for rapid debug and ramp to production in '00

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Bringing Merced to Production

- **Initial Step: Functional bring-up**
  - ◆ Testing teams will prioritize functional tests first
  - ◆ Strong focus on architecture validation, MP, and availability features
  - ◆ Ensure requirements of target segments are met
  - ◆ Work closely with external test partners

- **Planned steppings to production**
  - ◆ Broad prototype system deployment by Intel and OEM's
  - ◆ Performance testing/tuning accelerates
  - ◆ Extensive reliability testing

- **Production schedule**
  - ◆ 9 -12 months after first silicon
  - ◆ "Pre-production" samples to OEM's for testing and qualification about 3 months prior to production release

Merced debug/prototype process and timeframe similar to 386, 486, Pentium® Pentium® Pro

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IA-64 Validation Focus

- **Significant pre-silicon testing activity completed**
  - ◆ Successful boot of OS kernels on Merced logic model
  - ◆ Post tapeout analysis demonstrated excellent functionality
  - ◆ 460GX system platforms assembled, powered-up and tested

- **Early silicon testing program in place and executing**
  - ◆ Multiple test platforms to test various configurations
  - ◆ Processor testing uses real OS's and applications

- **OEM testing partners ready**
  - ◆ Variety of system designs in place (from 4 to 64 processors)
  - ◆ Most OEM chipsets complete and integrated into systems
  - ◆ Working with OSV's to test and bring up OS's

Extensive testing for fastest production ramp

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IA-64 OS and Tools Status

- **All OS's running in Merced simulation environment**
  - ◆ All OSV's on-track with hardware bring up
  - ◆ Outstanding Linux progress by Trillian team
  - ◆ Beta OS releases targeted for 1H'00 IA-64

- **Software developer training started Q4'98**
  - ◆ ISV event in 4/99 with hundreds of attendees
  - ◆ Technical training to developers - ~4 since Jan'99
  - ◆ Software documents available e.g. ADAG, Program Conventions

- **Key compiler/development environments available**
  - ◆ Microsoft, IBM/SCO, HP, Novell, others
  - ◆ Cygnus and SGI have delivered prototype gcc compiler tools

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IA-64 Compiler Technology Ready

- **Excellent functionality**
  - ◆ IA-64 features applied to a wide variety of code - FP, Integer, Transaction Processing
  - ◆ Within 90% of key performance benchmark estimates
  - ◆ Microsoft, IBM, EPC and other compilers on track

- **Technology Examples:**
  - ◆ Inlining & cloning benefits object oriented code e.g. C++, Java
  - ◆ Strength reduction + post increment helps scientific applications
  - ◆ Predication directly benefits large database applications
  - ◆ Software Pipelining improves performance of all integer and FP code

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Merced High Availability Features

Availability
- **Detect errors**
- **Correct errors**
- **Contain errors**
- **Recover from errors**

- **Enhanced Machine Check Architecture**
  - ◆ Processor, firmware, and OS coordinate error handling
  - ◆ Maximizes error correction before they cause downtime
  - ◆ Error tagging feature allows uncorrectable errors to be contained without downtime

- **ECC on large and medium sized arrays**

- **Built-in self test to validate integrity of logic & caches**

- **On-die thermal sensors**

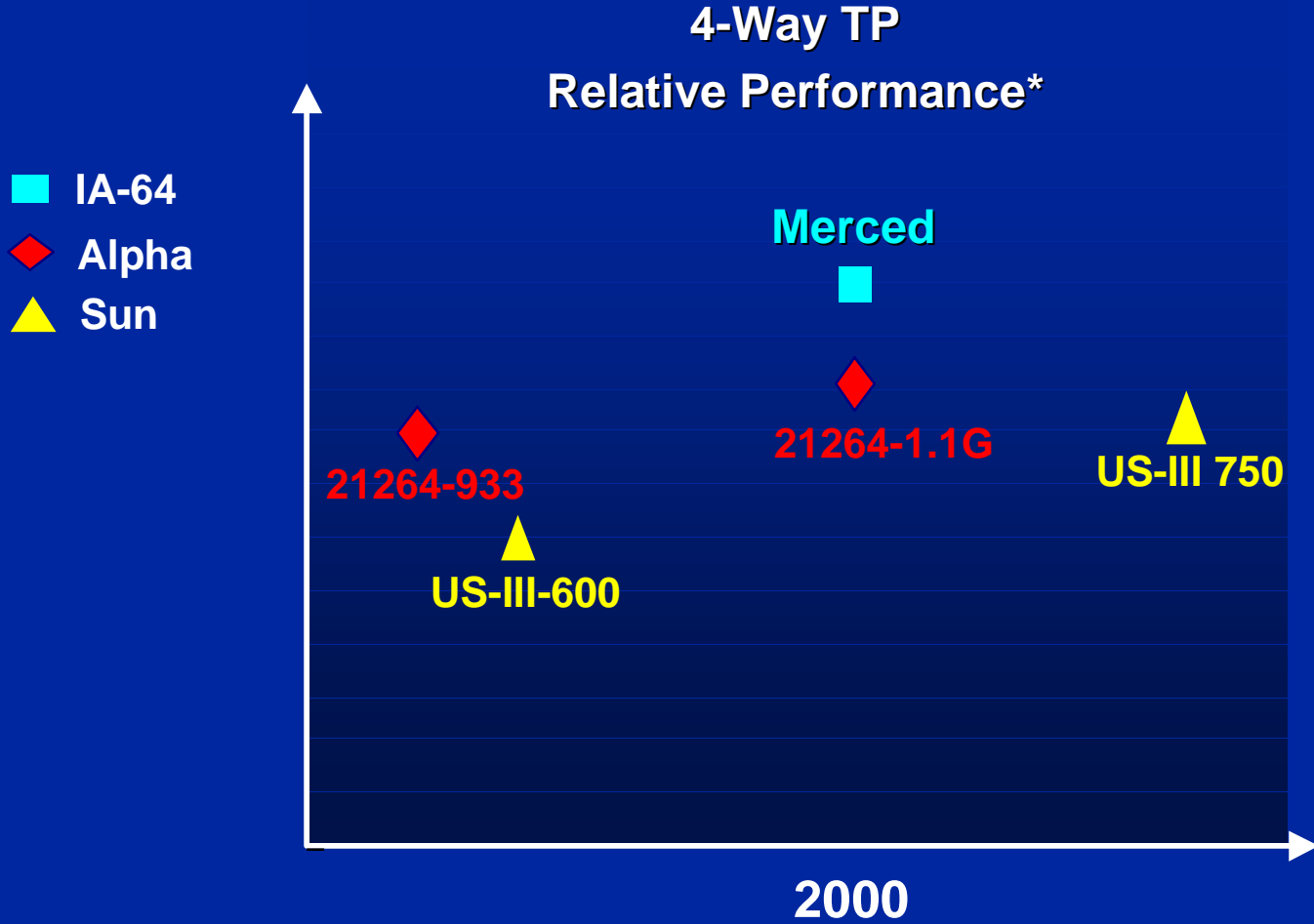*Designed to deliver the availability solutions for mission critical applications*

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Merced Scalability Features

Scalability	■ 4 MB L2 Cache ■ Enhanced deferred transactions ■ Flexible page sizes

- **Designed for massive multiprocessor scalability**
  - ◆ High bus bandwidth
  - ◆ Transaction deferral - out of order, non-blocking transactions
  - ◆ Advanced inter-processor interrupt architecture

- **Enhanced memory support**
  - ◆ 64 bit memory architecture
  - ◆ Flexible page sizes (4KB - 256MB)

- **Large 4MB on-cartridge L2 cache**
  - ◆ Keeps data local, reduces bus traffic

Enhanced scalability for large multiprocessor systems

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Merced Processor High Performance Computing for Servers

4-Way TP
Relative Performance*

IA-64
Alpha
Sun

Merced

21264-1.1G

21264-933

US-III 750

US-III-600

2000

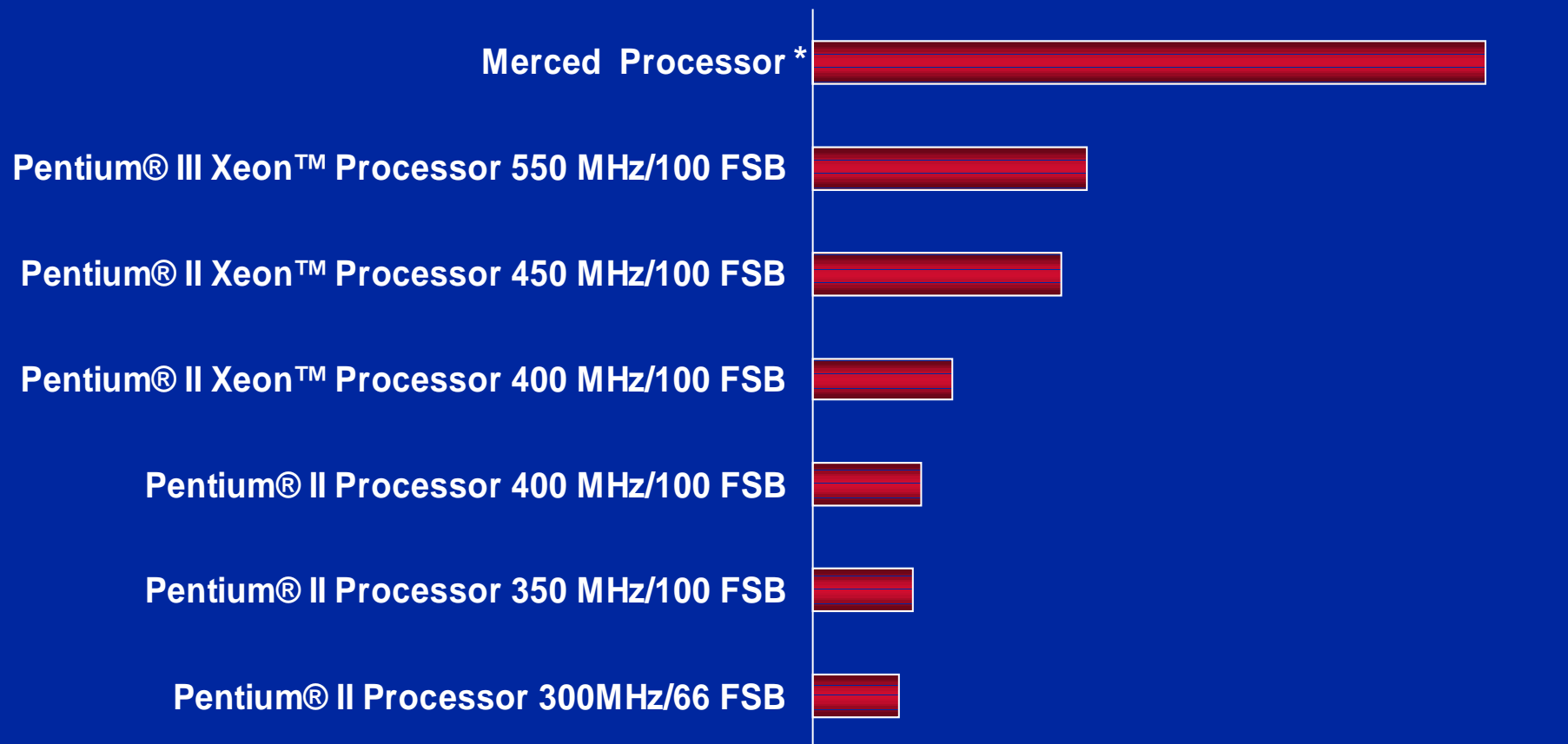*Source: Intel Projections, 8/99, Micro Design Resources

Merced Processor High Performance Computing for Workstations

- **Features for outstanding graphics performance:**
  - ◆ **4 FMACs perform multiply & add sequence in one cycle**
    - ■ **Over 6 Gigaflops peak performance**
  - ◆ **Two dedicated SIMD floating point execution units**
  - ◆ **High bandwidth from processor to memory to graphics card**

- **Architectural features for workstations:**
  - ◆ **128 floating-point registers: rotating, not stacking**
  - ◆ **IA-64 can treat general registers as 8x8, 4x16, or 2x32 bit**
    - ■ **Speeds SIMD operations**
  - ◆ **IA-64 instructions semantically compatible with MMX Technology**
  - ◆ **Fully binary compatible with IA-32 code**

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NASTRAN Performance Projections

Merced Processor *	████████████████████████████████
Pentium® III Xeon™ Processor 550 MHz/100 FSB	████████
Pentium® II Xeon™ Processor 450 MHz/100 FSB	███████
Pentium® II Xeon™ Processor 400 MHz/100 FSB	████
Pentium® II Processor 400 MHz/100 FSB	███
Pentium® II Processor 350 MHz/100 FSB	███
Pentium® II Processor 300MHz/66 FSB	██

* Projected

Merced extends the outstanding performance of IA workstations

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McKinley Processor

- **McKinley builds upon Merced Processor technology**
  - ◆ **Enhanced microarchitecture**
    - ■ **More execution units for greater IPC***
    - ■ **Large, high speed, on-chip caches**
  - ◆ **Target Frequency: >1 GHz**

- **Full Merced & IA-32 software compatibility**
  - ◆ **Merced software runs, and runs faster on McKinley without recompilation**

- **Production target: Late '01**

McKinley extends Merced Processor benefits

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*IPC = Instructions Per Clock Cycle

Agenda

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- **IA-64 Program Update**

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Broadening IA-64 Development

- **Intel 64 Fund established**
  - ◆ Equity investments in emerging IA-64 related technologies
- **IA-64 Application Developer's Architecture Guide released to public**
  - ◆ Precursor to the "Programmers Reference Manual"
  - ◆ More development guides throughout 2H '99
- **IA-64 Developer Information web site established**
  - ◆ http://developer.intel.com/design/ia64/devinfo.htm
- **OSV development tools publicly available**
  - ◆ Microsoft, Novell, HP, IBM/SCO, others

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IA-64 Development Timeline

	1999		2000

Merced	First OEM Samples	SDV Shipments	Production

OS	OS on Simulator	OS on Hardware	Beta OS's	Production

Tools	Initial SDK (Software Development Kit)	Beta SDK	Production SDK
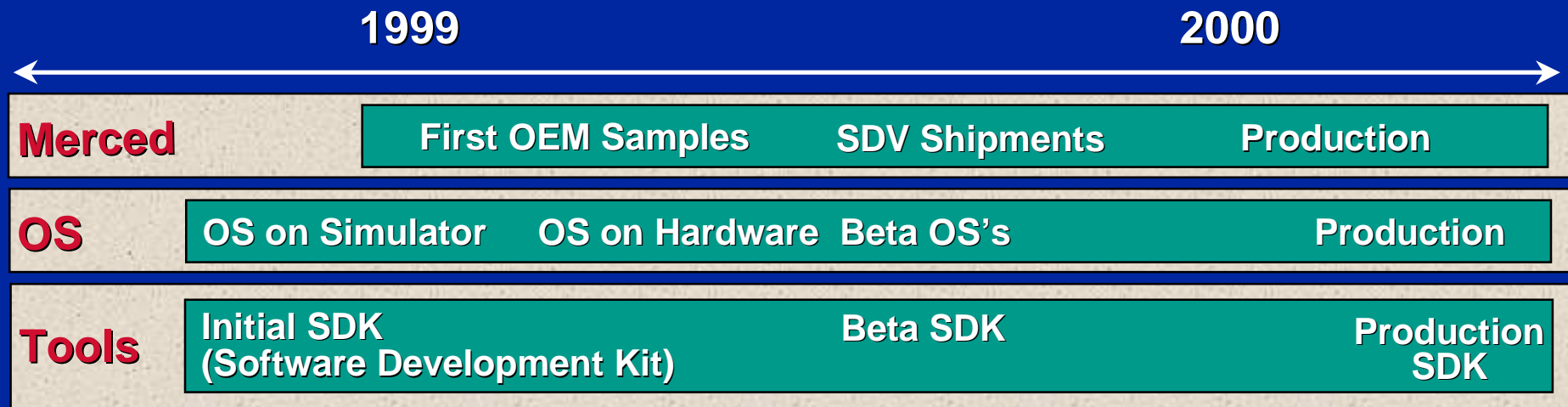
OEM: • **Get Ready for product introductions in '00**

   • **Attend "Merced System Overview", DIG64, and EFI Presentations**

   • **Continue Working with your Intel Field Representative**

ISV: • **Get Your Code IA-64 Ready Today**

   • **Attend IA-64 Track Software Presentations to Learn How**

IHV: • **Continue Getting Your Drivers 64-bit ready today**

   • **Attend IA-64 Track Software Presentations to Learn How**

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Summary

- **IA-64 is a unique opportunity**
  - ◆ **Opportunity to be a leader on the most significant architecture advancement since the Intel 80386**

- **IA-64 is Here**
  - ◆ **Merced is reality**
  - ◆ **Launch begins now . . .**

- **Get Started Today**
  - ◆ **Development tools and resources available now**
  - ◆ **The IA-64 Track will tell you how**

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