
Intel
Developer
Forum


The Era Of Tera
Pat Gelsinger
Chief Technology Officer
Senior Vice President
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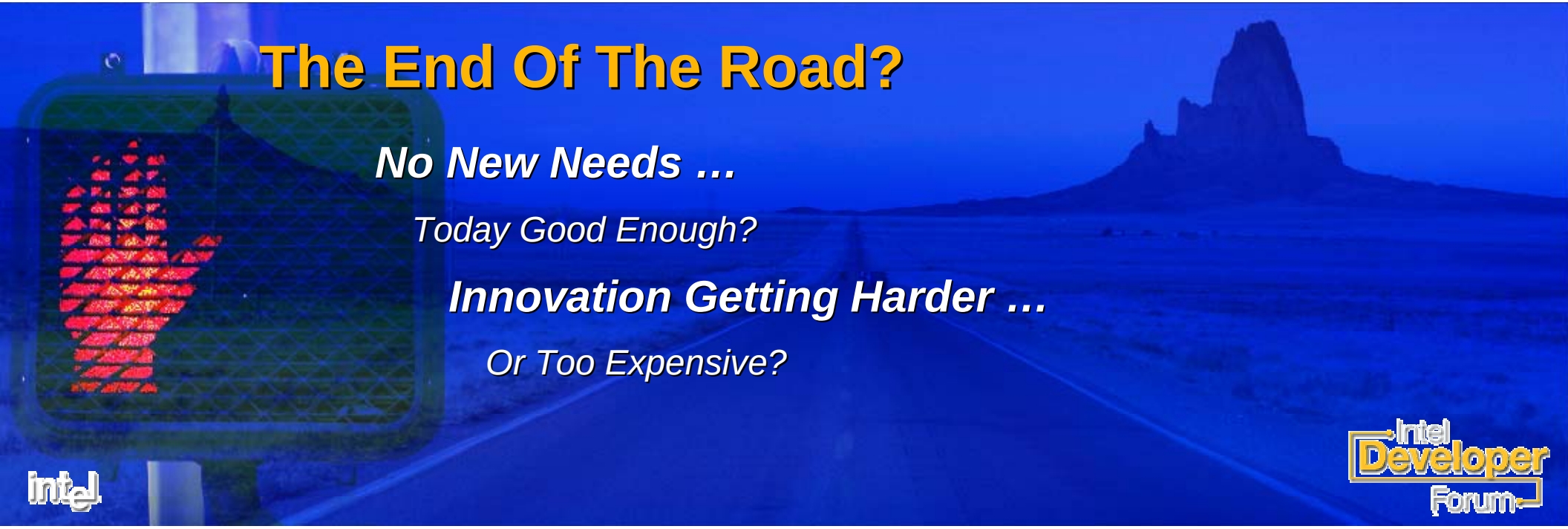
The Information Age

The Information Age

Innovation** Is The **Fuel

Need** Is The **Catalyst


The End Of The Road?
No New Needs …
Today Good Enough?
Innovation Getting Harder …
Or Too Expensive?
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Lessons From History

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Lessons From History

Lessons From History

Lessons From History

INFORMATIONWEEK ONLINE LANGALETTER

How Fast Is Fast Enough?

For new hardware, I think about 400-MHz is adequate for just about any application… So a 400-MHz box shouldn't become obsolete anytime soon.

Frank Langa
October 6, 1999

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Lessons From History

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Lessons From History

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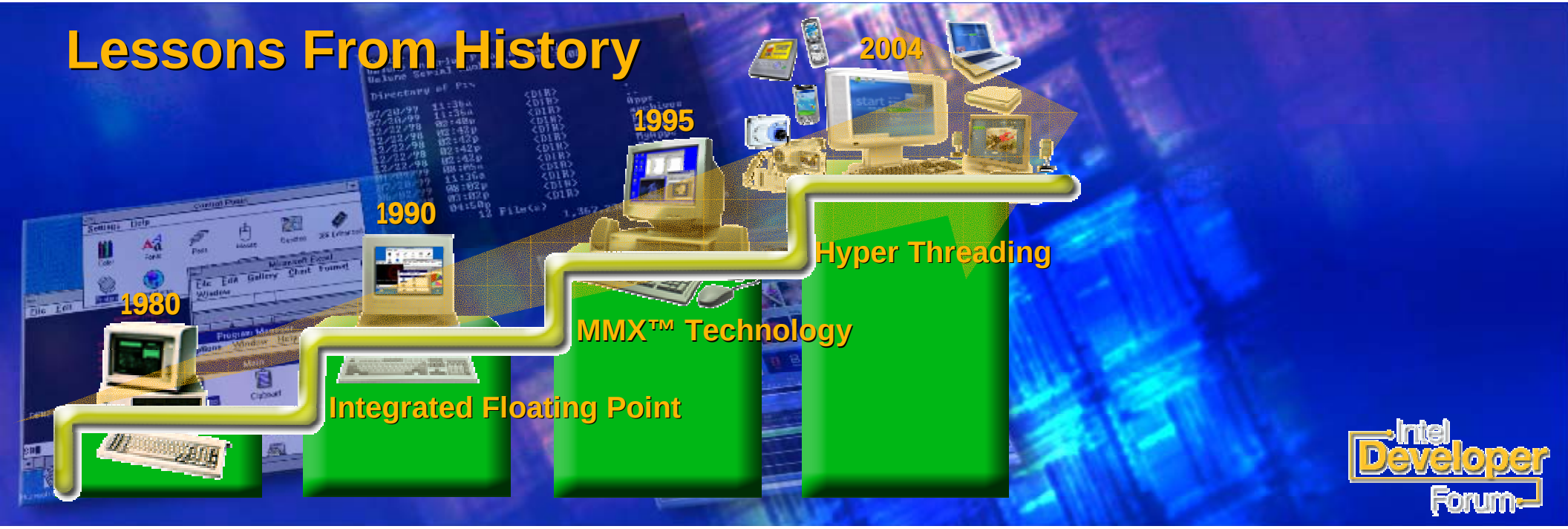
Lessons From History



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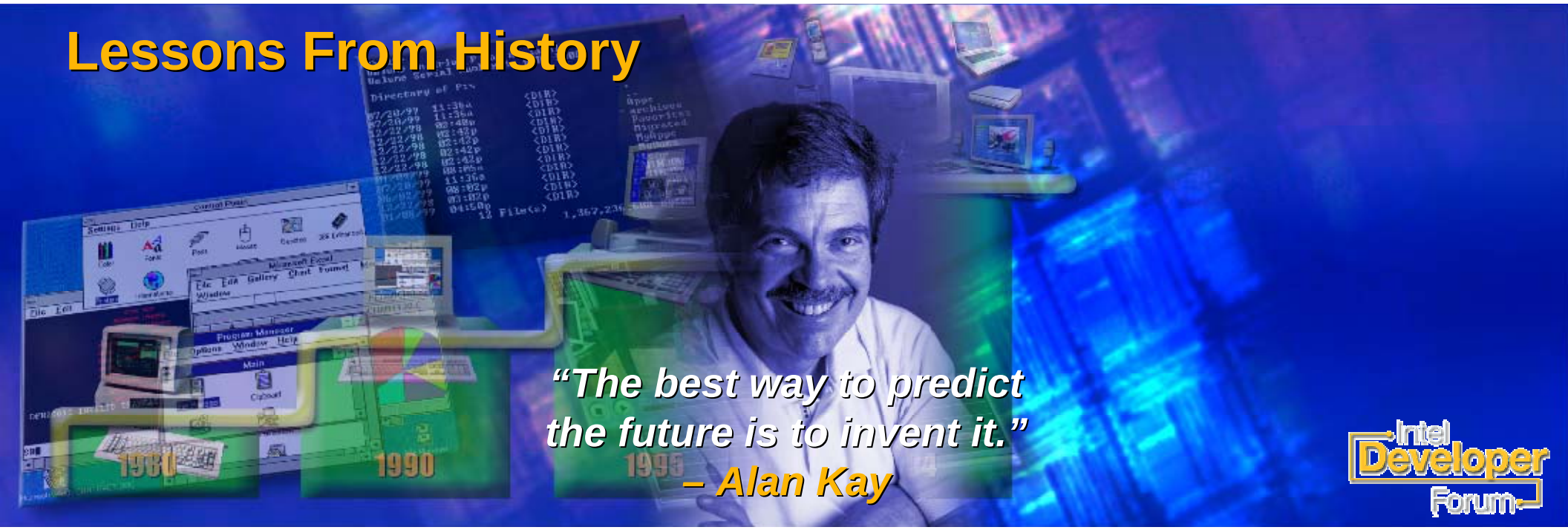
Lessons From History



"The best way to predict the future is to invent it."
– Alan Kay

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Today's Digital Transformation

Only The Tip Of The Iceberg

Byte = 8 bits
Kilobyte = 10^3
Megabyte = 10^6
Gigabyte = 10^9
Terabyte = 10^{12}
Petabyte = 10^{15}
Exabyte = 10^{18}
Zettabyte = 10^{21}
Yottabyte = 10^{24}

U.S. Broadcast Media	14,893 TB
Worldwide Filmed Content	420,254 TB
Worldwide Printed Content	1,633 TB

Internet	532,897 TB
World Telephone Calls	17,300,000 TB

Worldwide Magnetic Content	4,999,230 TB
Worldwide Optical Content	103 TB
Electronic Flows Of New Info	17,905,340 TB

Source: How much information 2003

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A Glimpse Of The Future

Digital Immersion

Beyond ***Creation & Consumption***

Every ***Minute****,*

Every ***Where****,*

Every ***Body***

The RMS View

The RMS View

Human-computer Interfaces
Multimodal Detection
Statistical Computing
Clustering and Classification
Machine Learning

The RMS View

- Streaming Data Mining
- Web Mining
- Content-based Image Retrieval
- Summarization

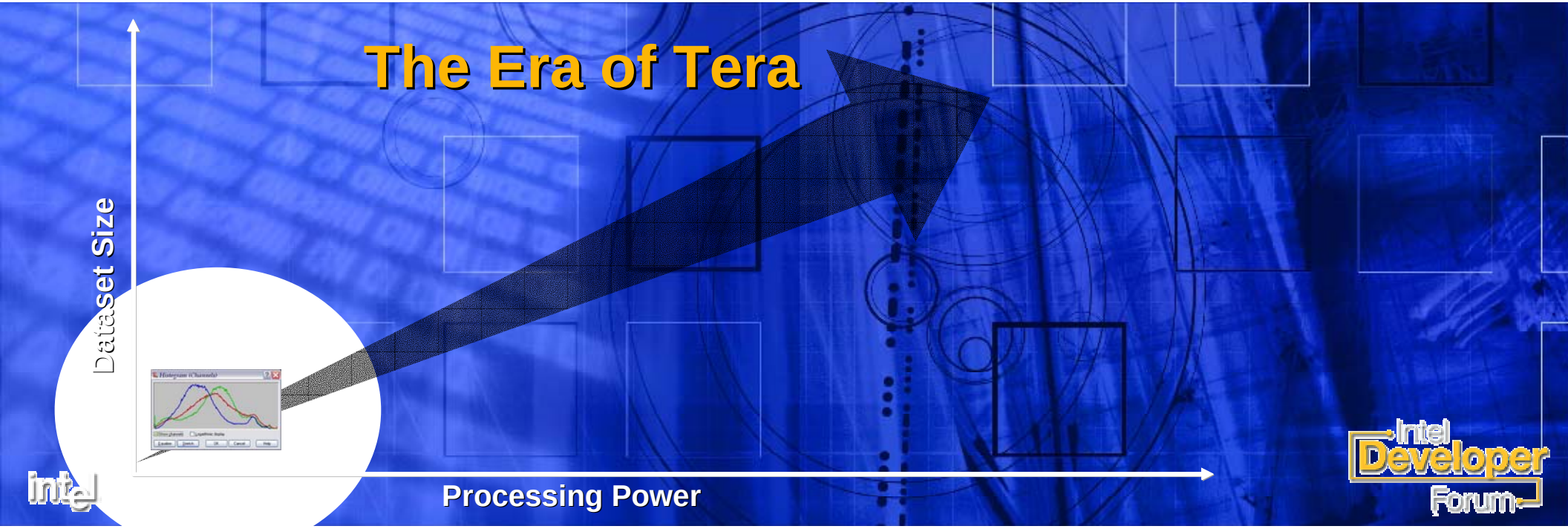
The RMS View

- Photo-realism
- Real-world Animation
- Audio/Video/Image Synthesis
- Document Synthesis

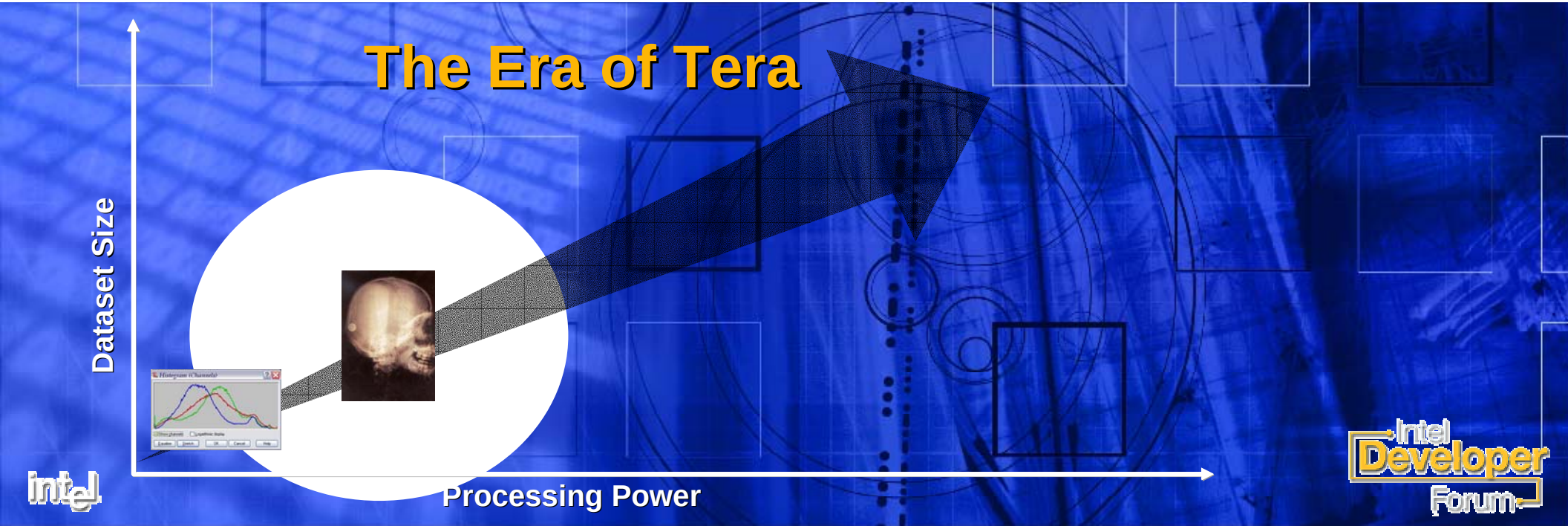
The RMS View

Workload Convergence
Driving **Architectural**
Convergence

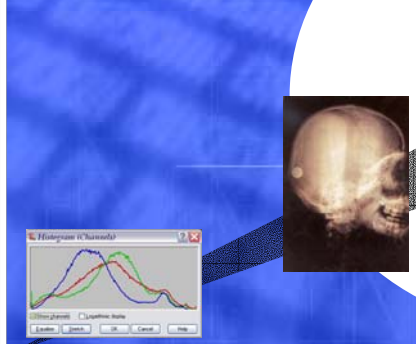
The Era of Tera

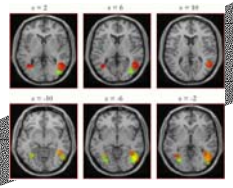


The Era of Tera



The Era of Tera





Dataset Size

Processing Power

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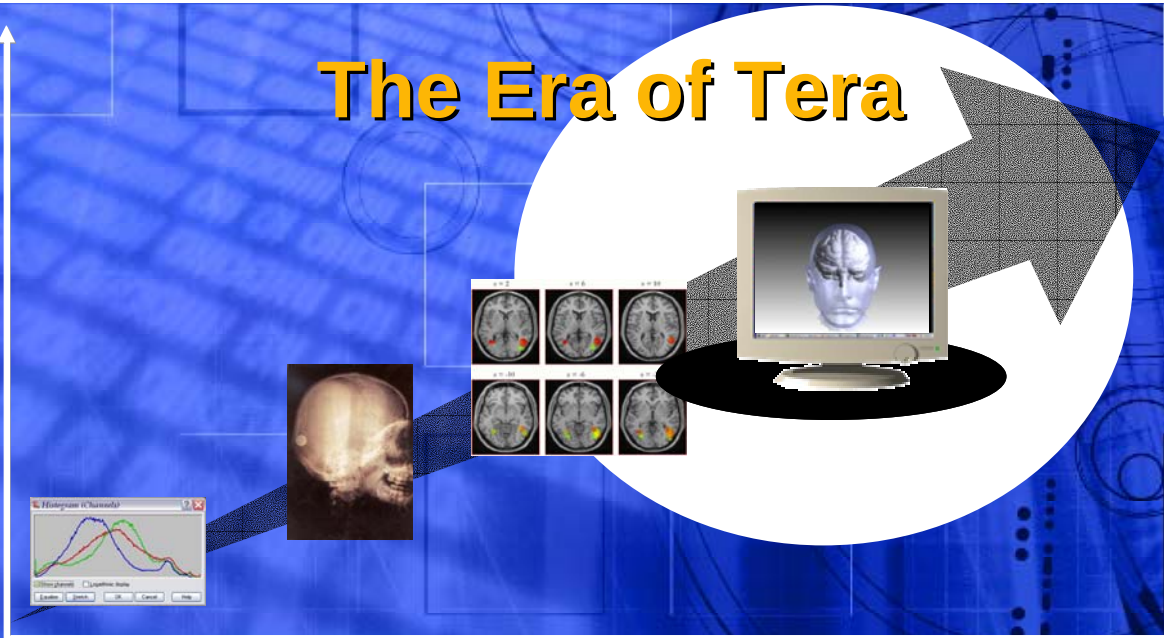
The Era of Tera



Dataset Size

Processing Power

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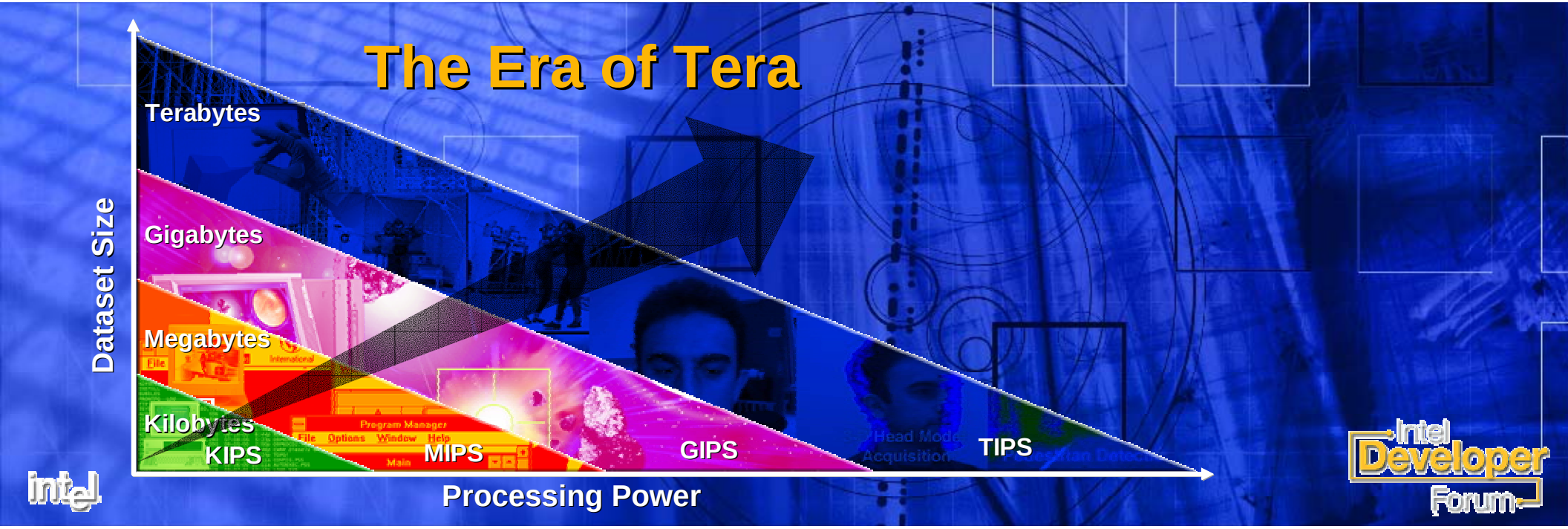
The Era of Tera
Terabytes
Gigabytes
Megabytes
Kilobytes
KIPS
MIPS
GIPS
TIPS
Dataset Size
Processing Power
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Recognition
Mining
Synthesis


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Philipp Slusallek

- Professor for Computer Graphics, Saarland University, Germany
- Visiting Assistant Professor Stanford University, 1998 - 1999
- Co-founder of “inTrace GmbH”

INTRACE
REALTIME RAY-TRACING TECHNOLOGIES

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Rasterization vs. Ray Tracing

Rasterization

- Wrong reflection
- Incorrect shadows
- Complex content creation

Ray Tracing

- Reliable, true reflections and shadows
- Simple content creation
- Scalable

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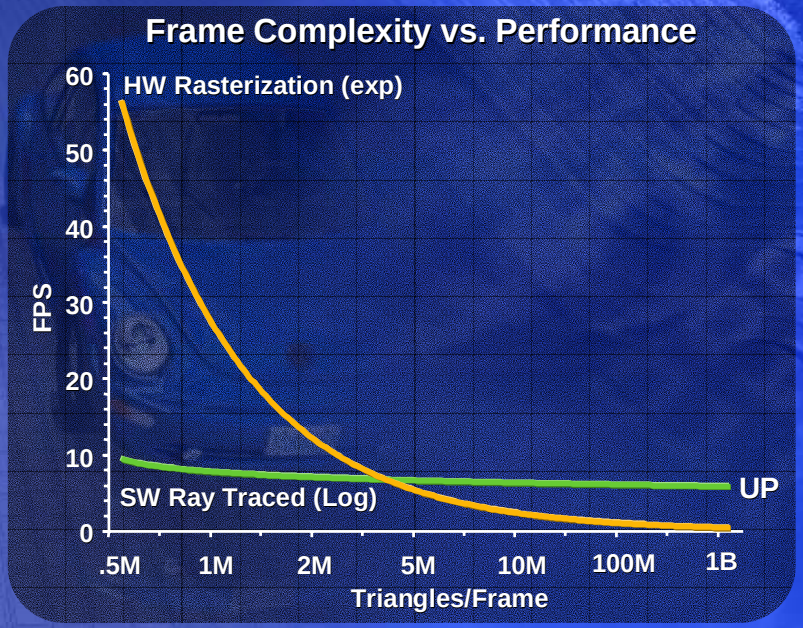
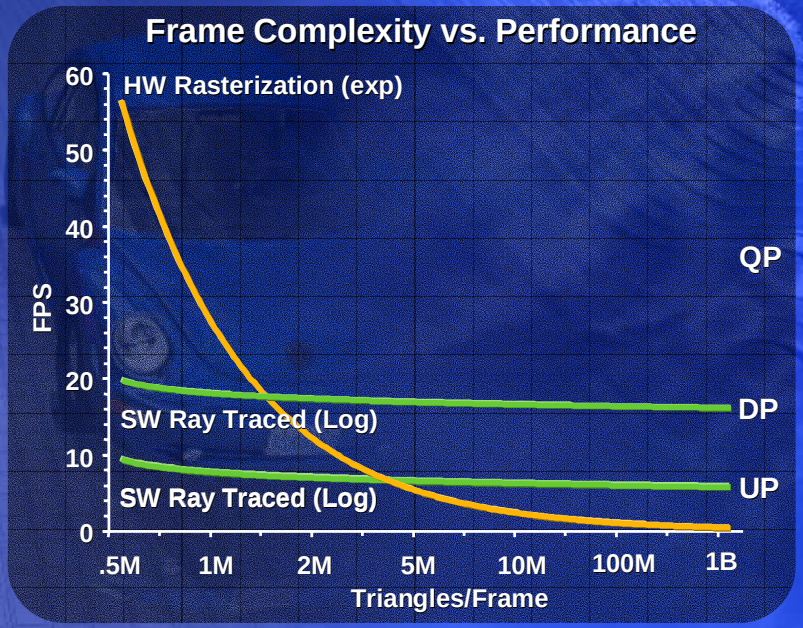
Sunflowers: one ***billion*** polygons and shadows (4 fps @ 640x480)

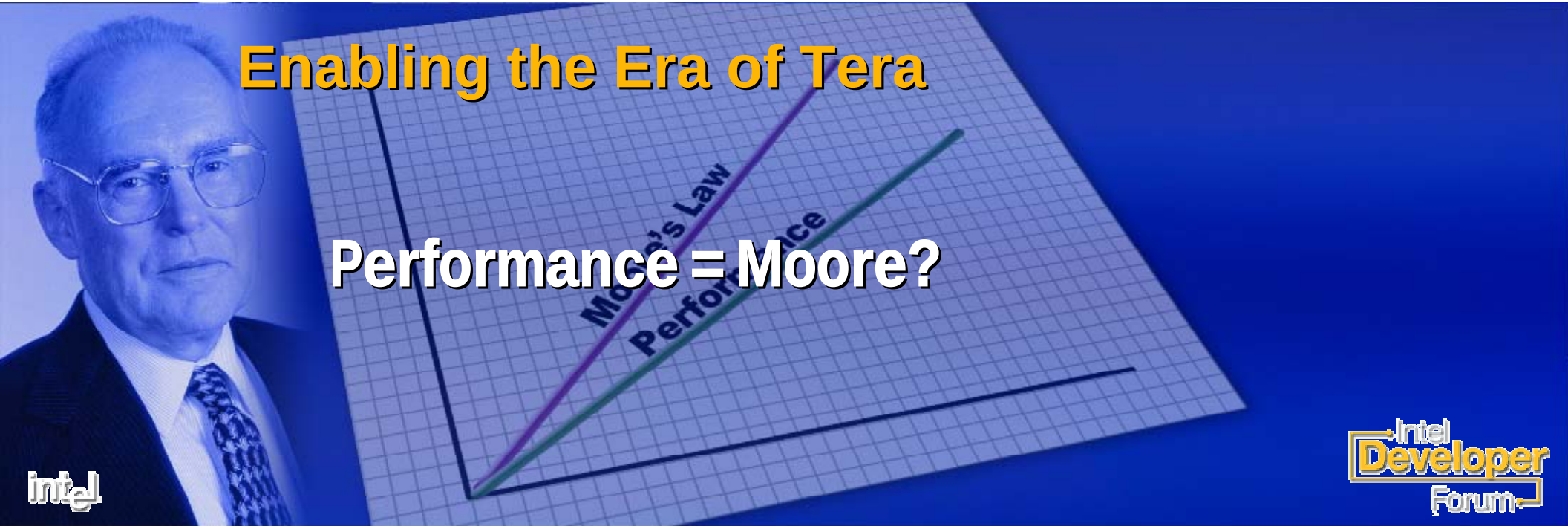


Sunflowers: one ***billion*** polygons and shadows (4 fps @ 640x480)

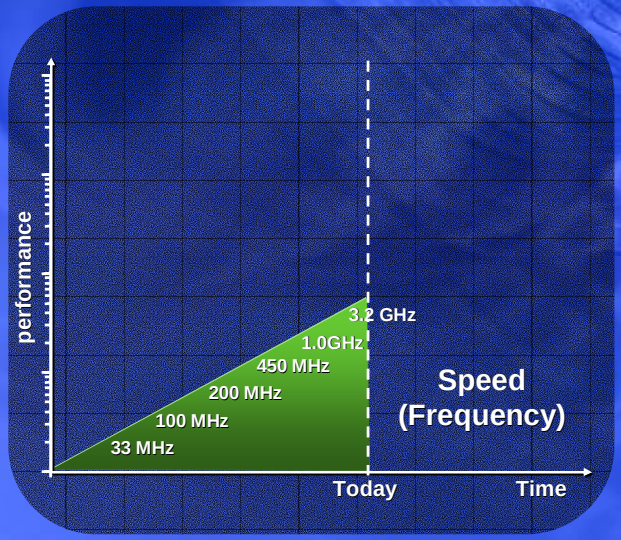


Enabling the Era of Tera

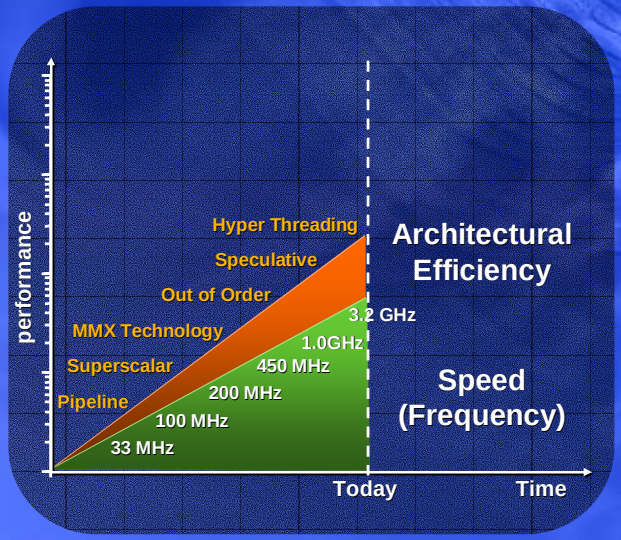
Enabling the Era of Tera



Enabling the Era of Tera



Enabling the Era of Tera



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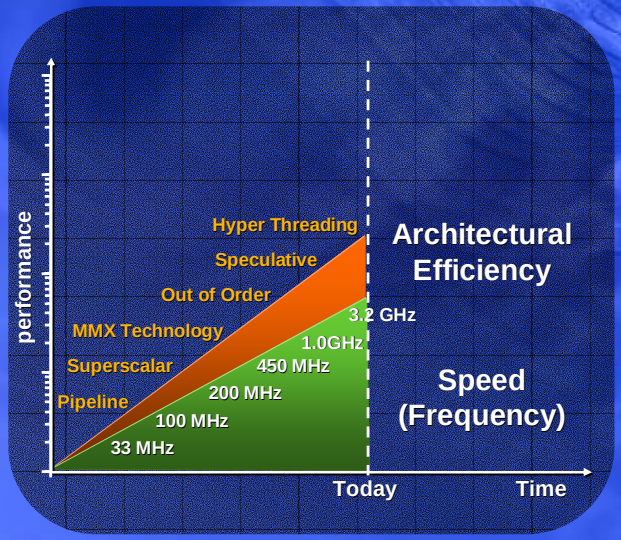
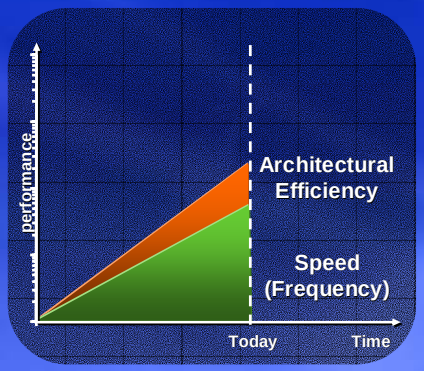
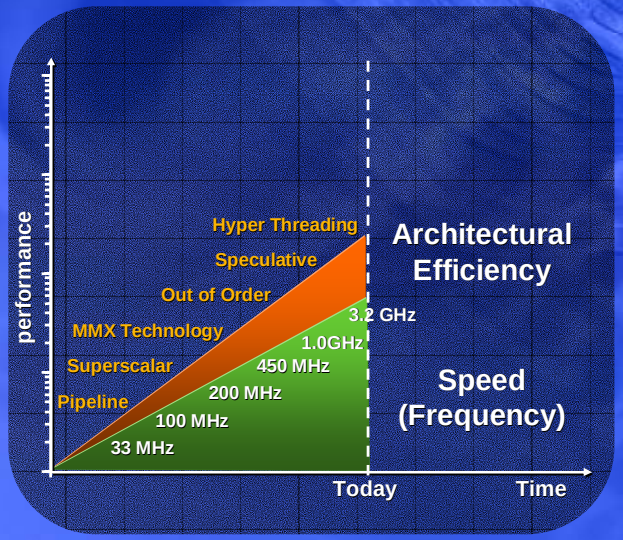
Performance =
Speed
+
Architectural
Efficiency



Enabling the Era of Tera





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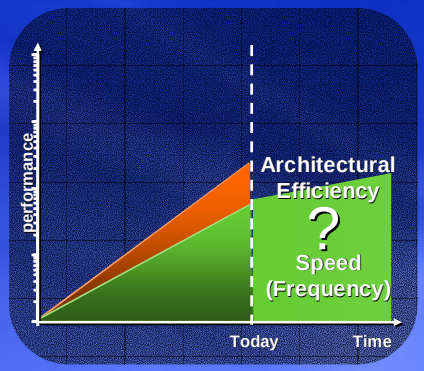

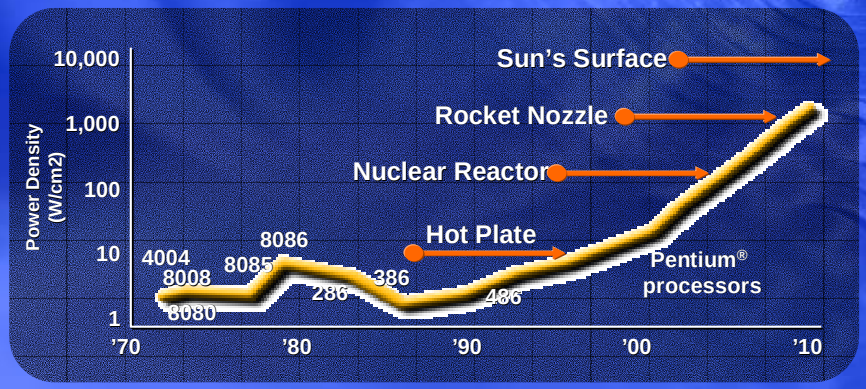

Power

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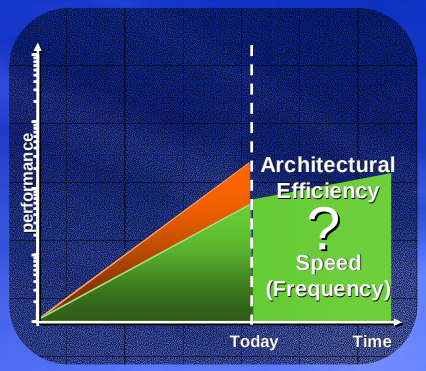
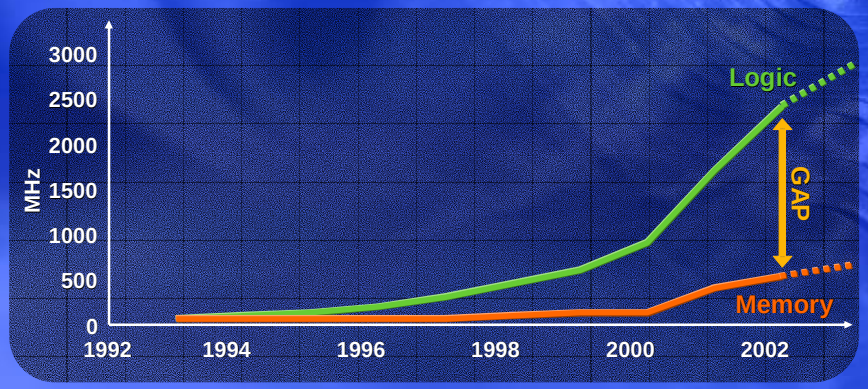
Enabling the Era of Tera





Memory Latency

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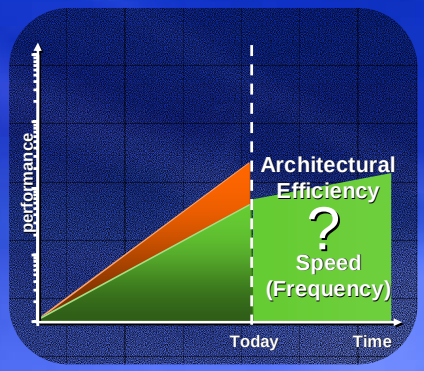
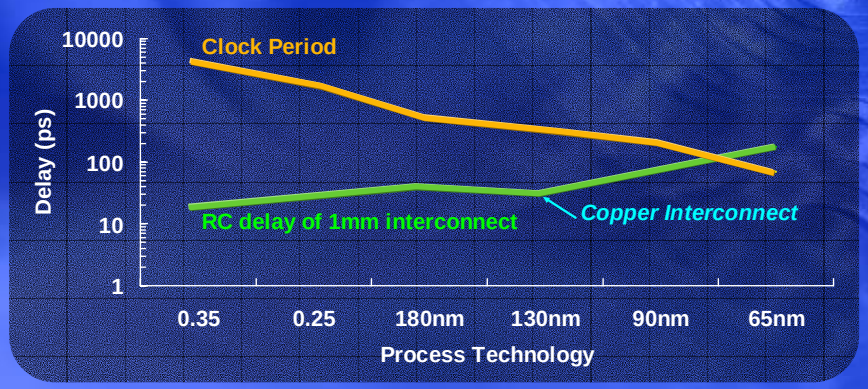
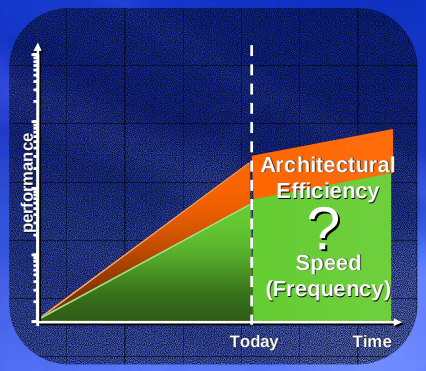
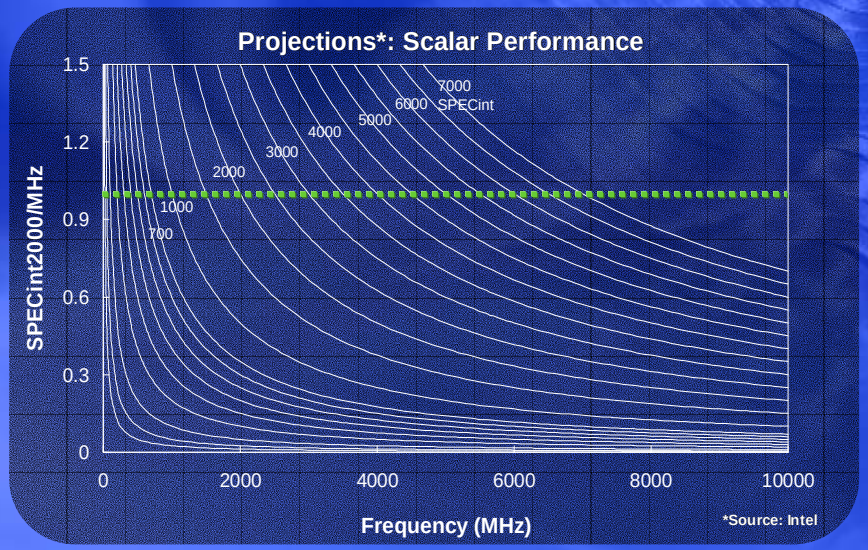




Interconnect RC Delay

Enabling the Era of Tera





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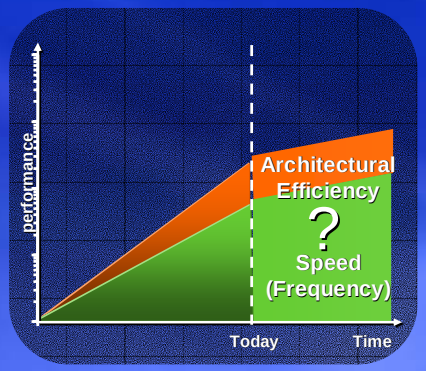

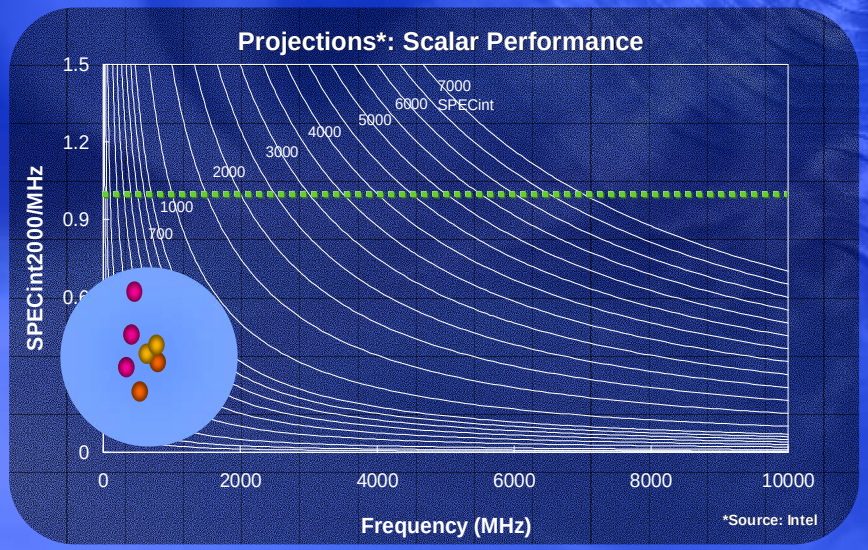

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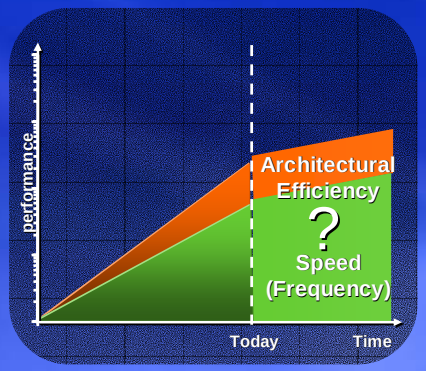

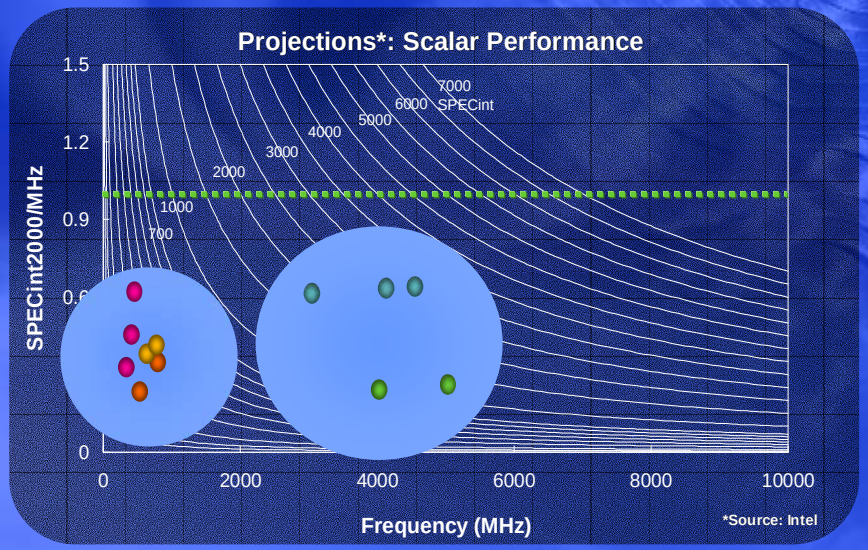

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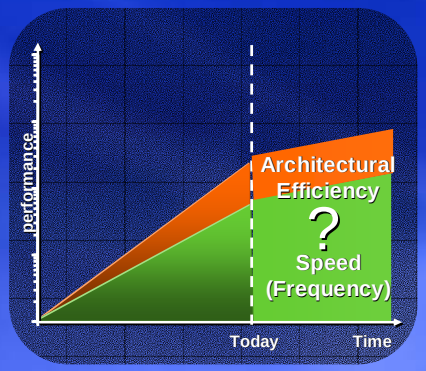
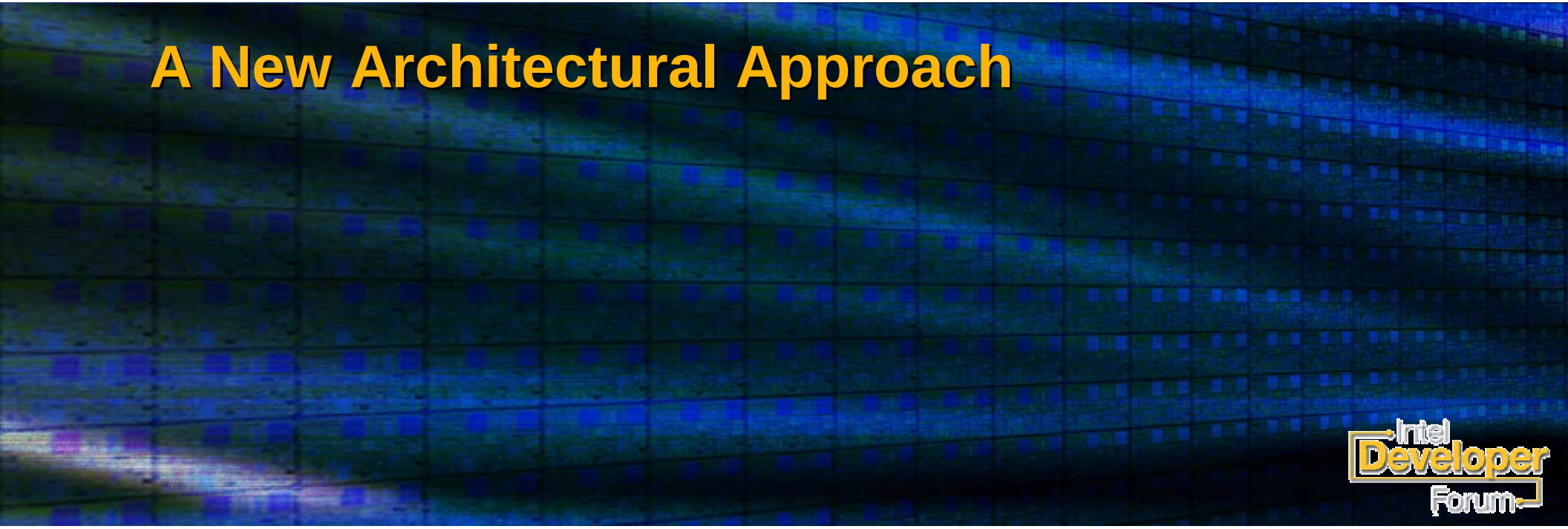
Enabling the Era of Tera



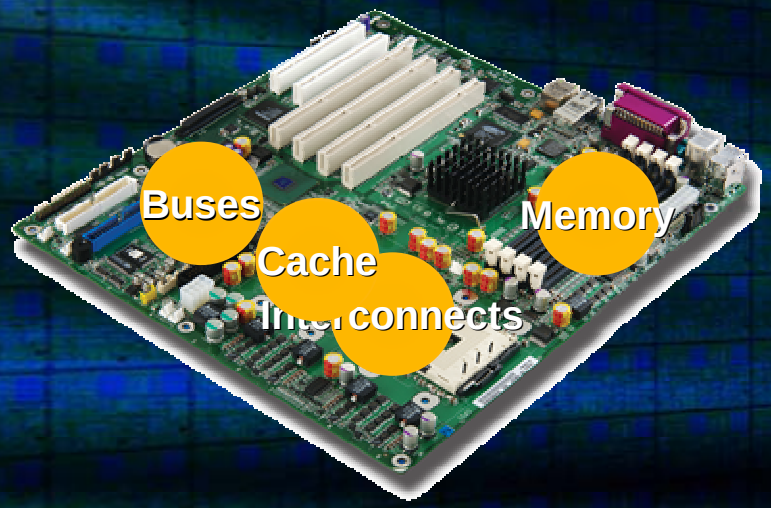
Need An Architectural
Paradigm Shift

A New Architectural Approach



A New Architectural Approach

Platform Focused



A New Architectural Approach

Scalability

Adaptability

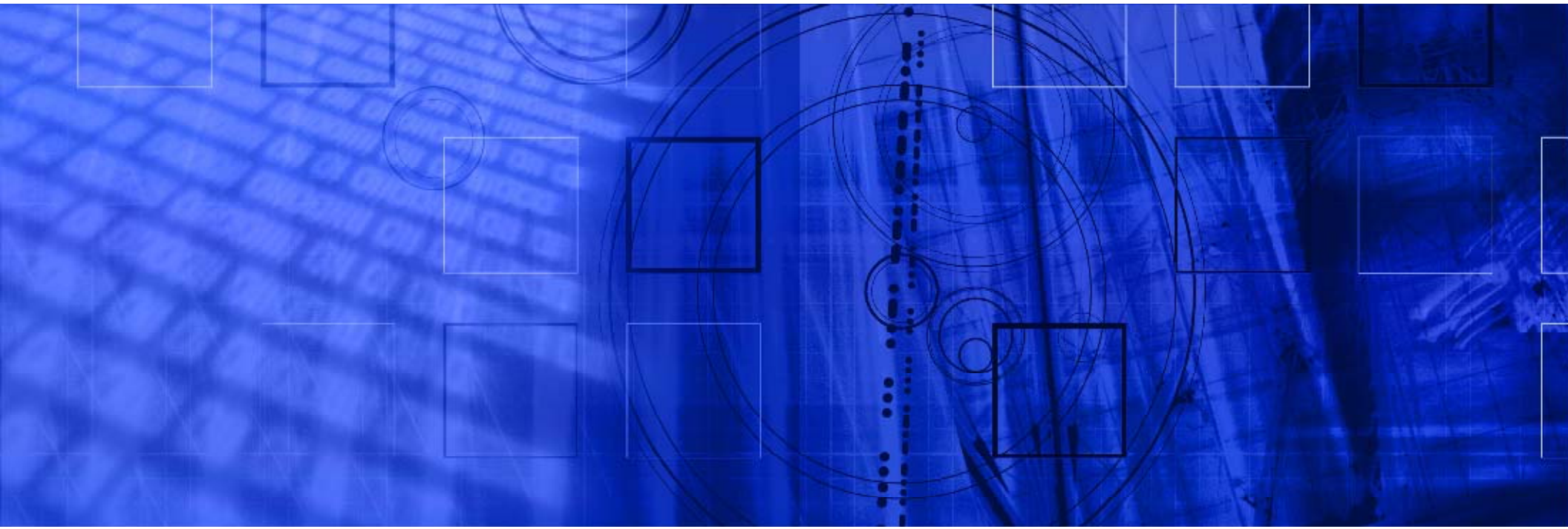
Programmability

Scalability

Exploiting

Concurrency

At *Multiple* Levels




Adaptability
Adapting To
Workload-driven
Power-performance
Requirements
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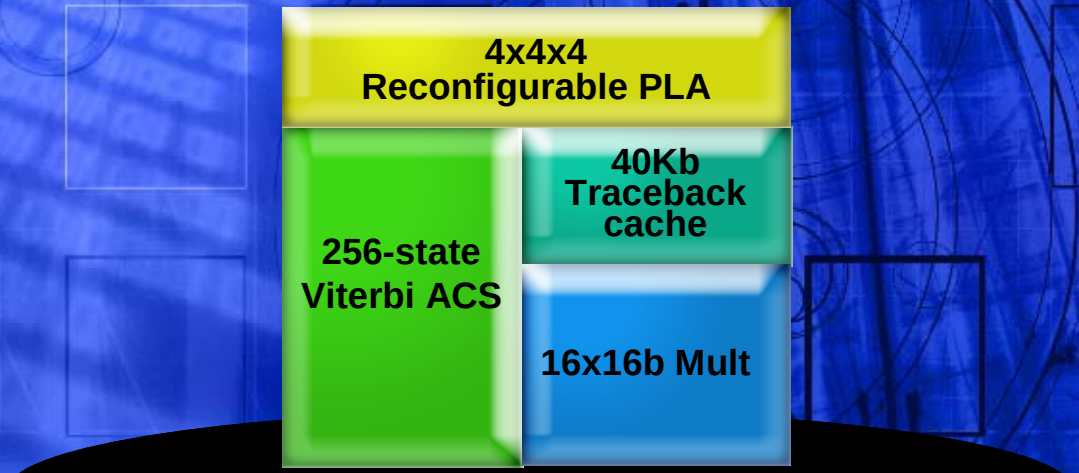
Adaptive Silicon

Adaptive

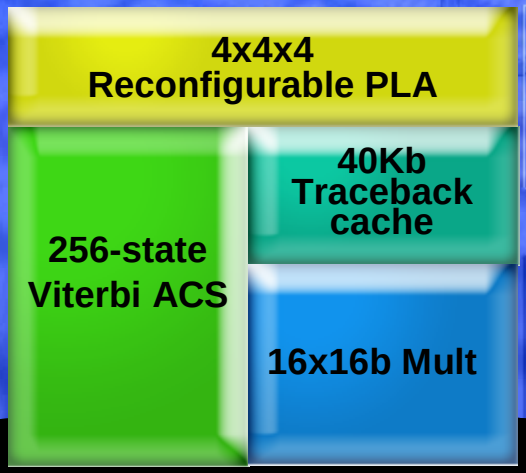
Body

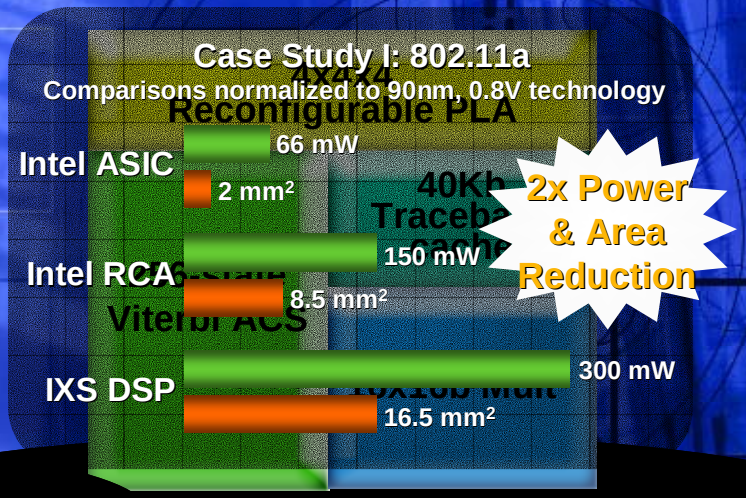
Biasing

Adaptive Micro-architecture



Adaptive Micro-architecture





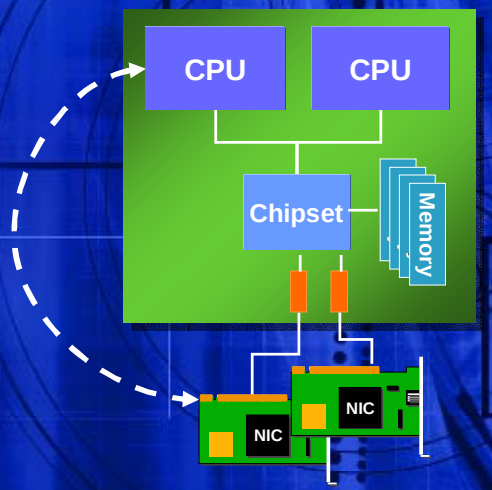
Source: Intel Estimates

Adaptive Platform
Packet Processing Challenge

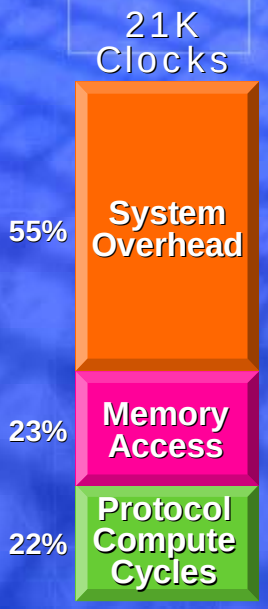
Maximize CPU Cycles For
User Applications

Yet...

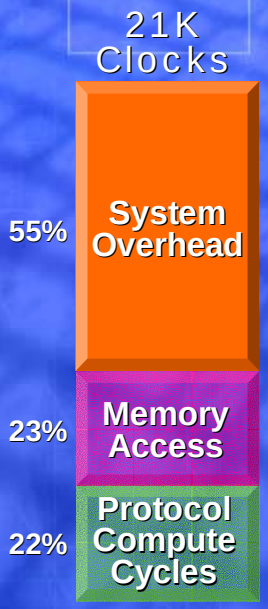
Process Packet Payloads
At **Line Rates**

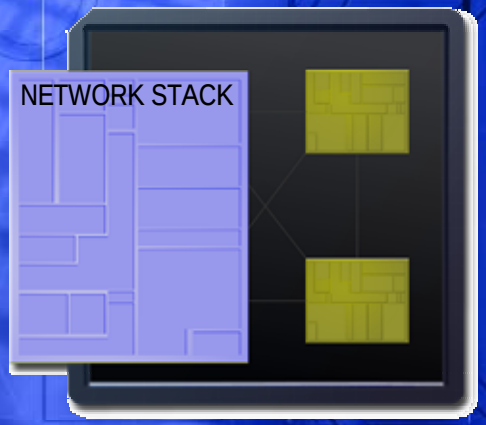


Adaptive Platform



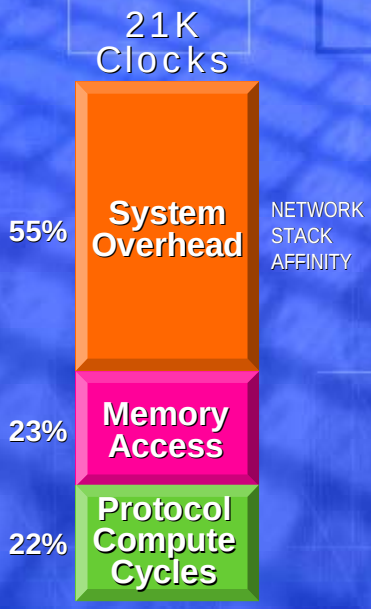
Adaptive Platform

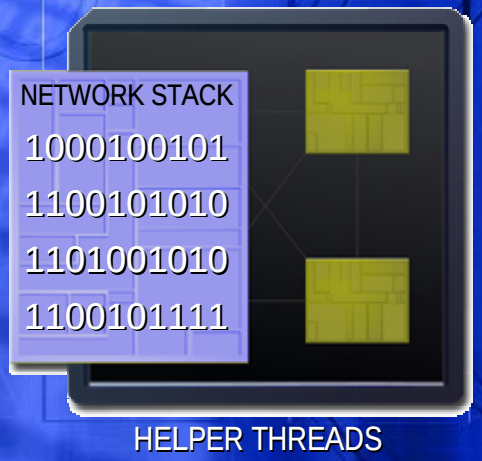




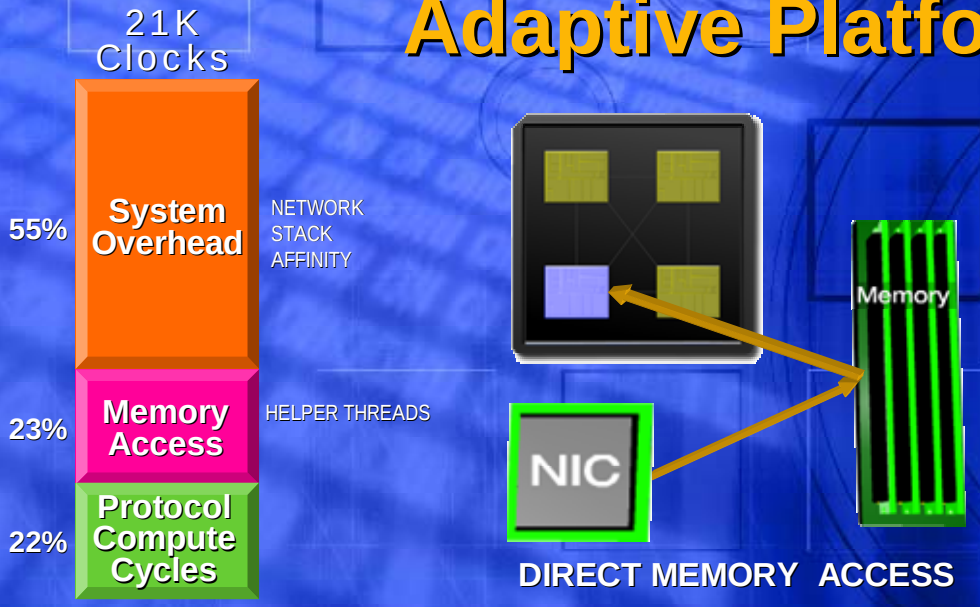
NETWORK STACK AFFINITY

Adaptive Platform





Adaptive Platform



DIRECT MEMORY ACCESS

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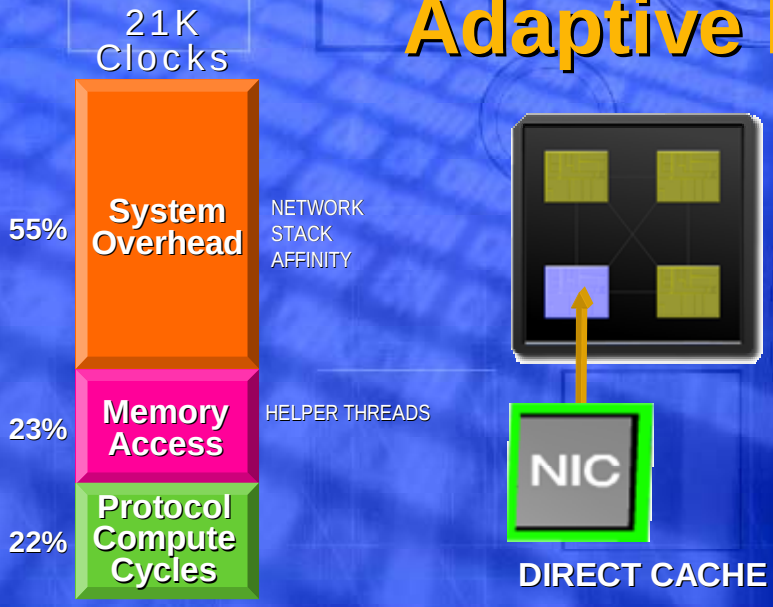
Adaptive Platform



DIRECT CACHE ACCESS

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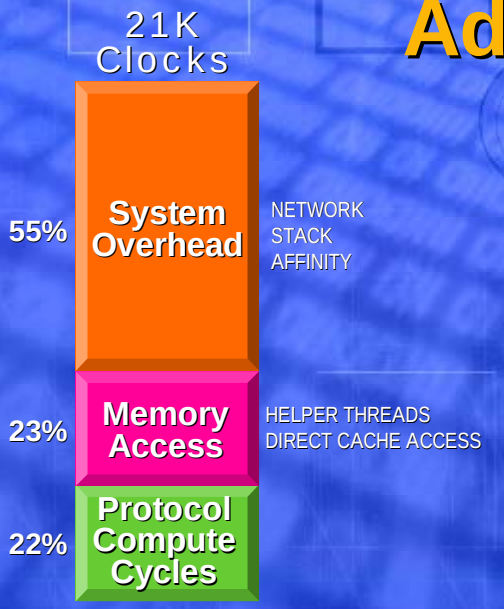
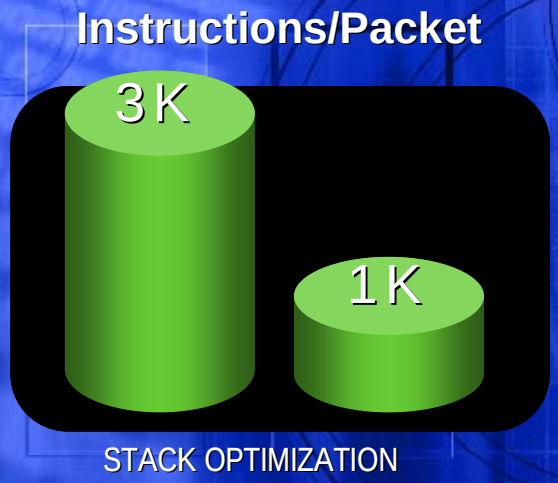
Adaptive Platform





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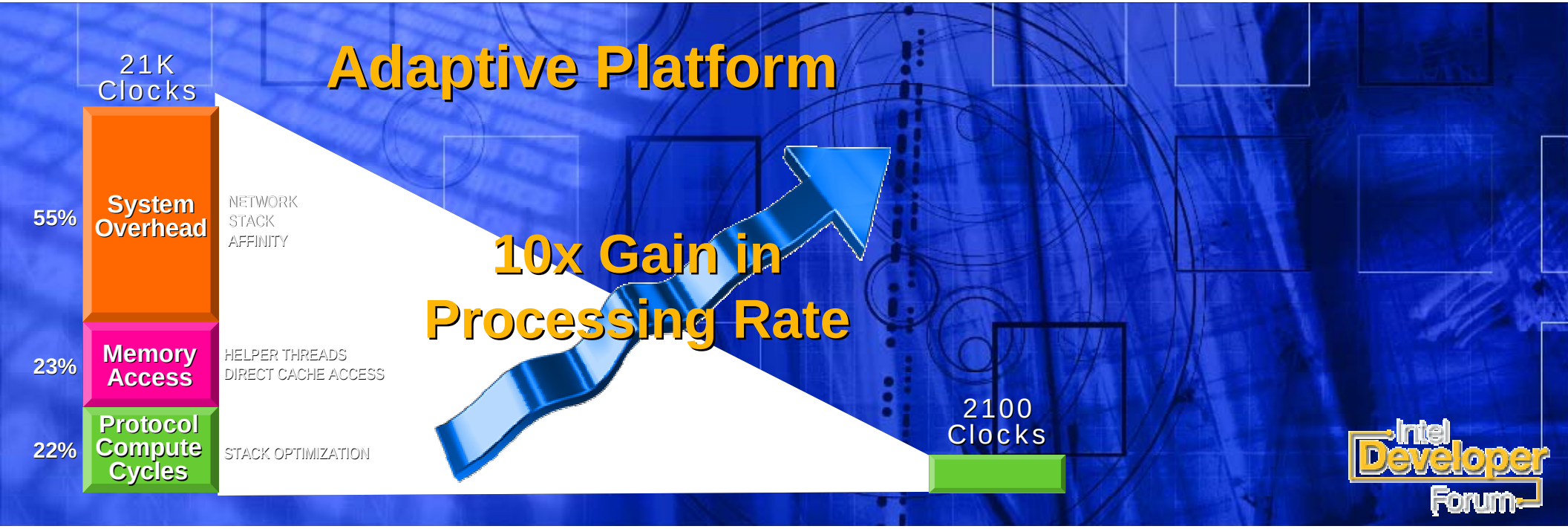
Adaptive Platform
21K Clocks
55%
System Overhead
NETWORK STACK AFFINITY
23%
Memory Access
HELPER THREADS DIRECT CACHE ACCESS
22%
Protocol Compute Cycles
STACK OPTIMIZATION
10x Gain in Processing Rate
2100 Clocks
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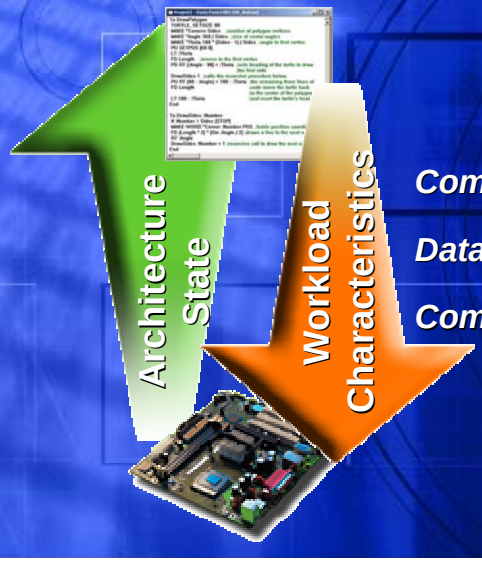
Programmability

Programmability

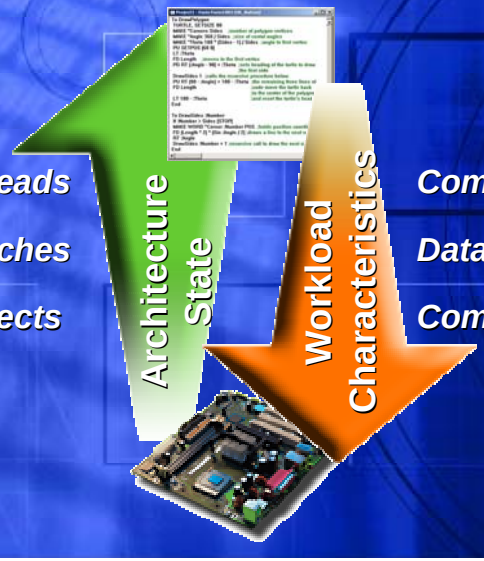


Computational Concurrency

Data Decomposition

Communication/Synchronization

Programmability



Cores/Threads

Adaptable Caches

Adaptable Interconnects

Computational Concurrency

Data Decomposition

Communication/Synchronization


Enabling the Era Of Tera
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Enabling the Era Of Tera
Innovation = Multi-everywhere
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Enabling the Era Of Tera

*Innovation = **Multi-everywhere***

*Catalyst = **Digital Transformation***


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Q&A
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