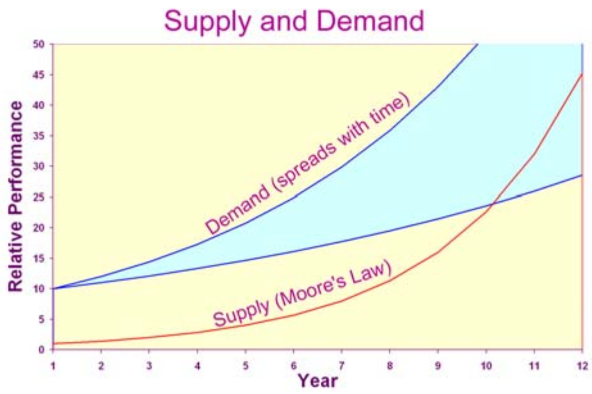
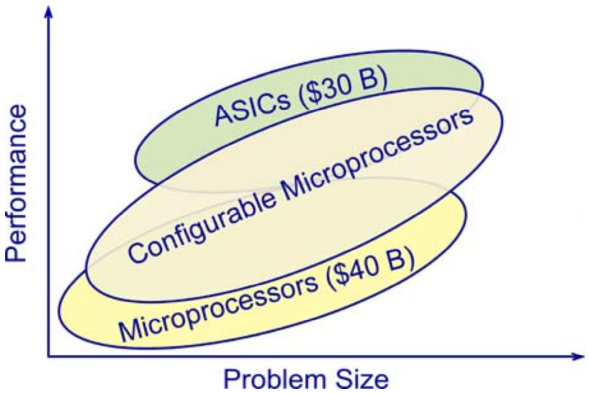
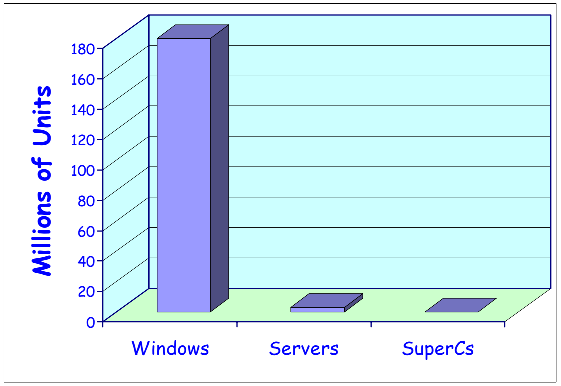
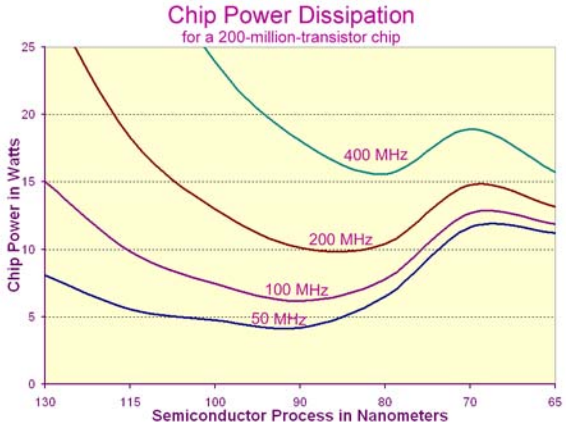
# Semiconductor Trends 2005





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*Gilder Technology Report*

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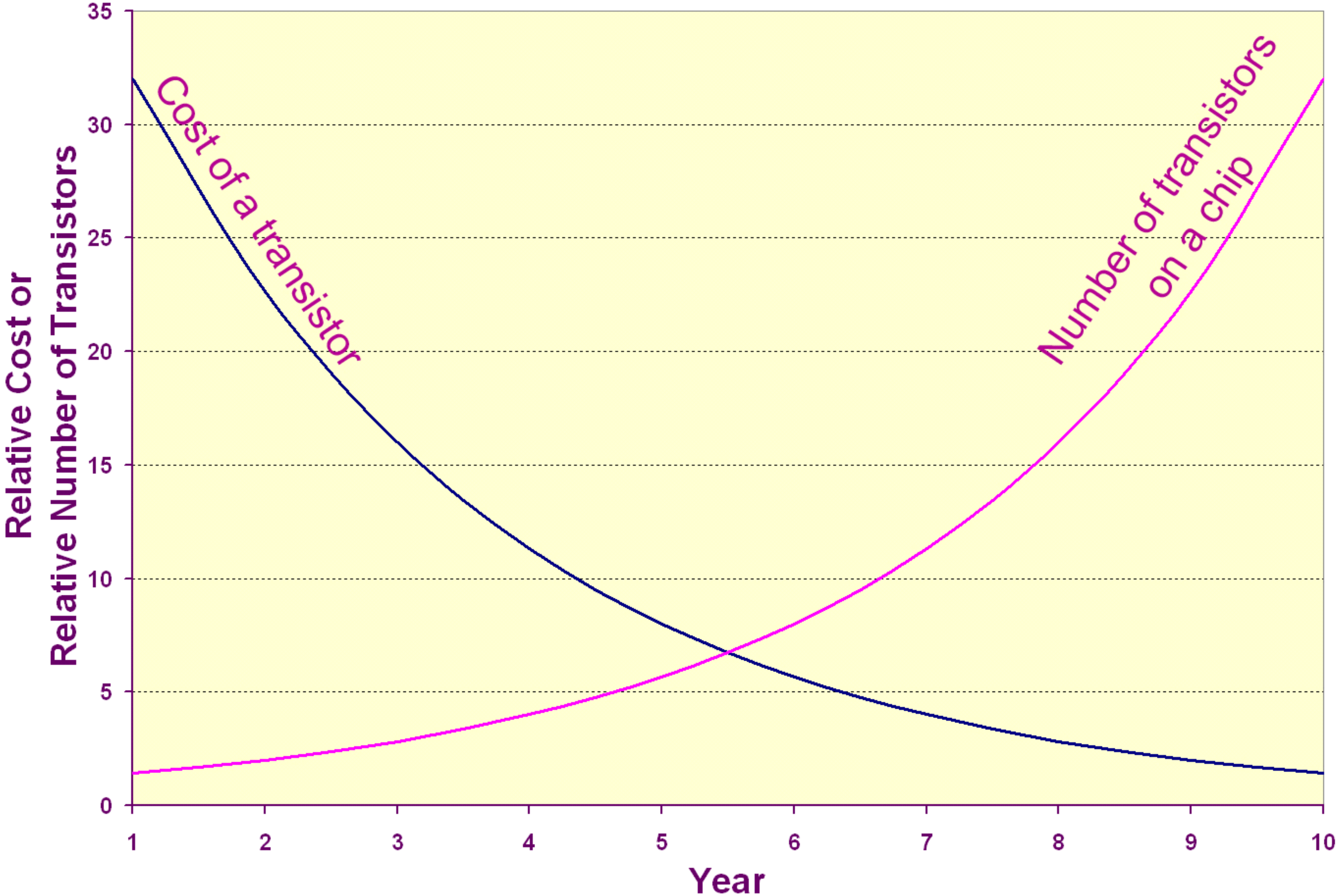
# Overview

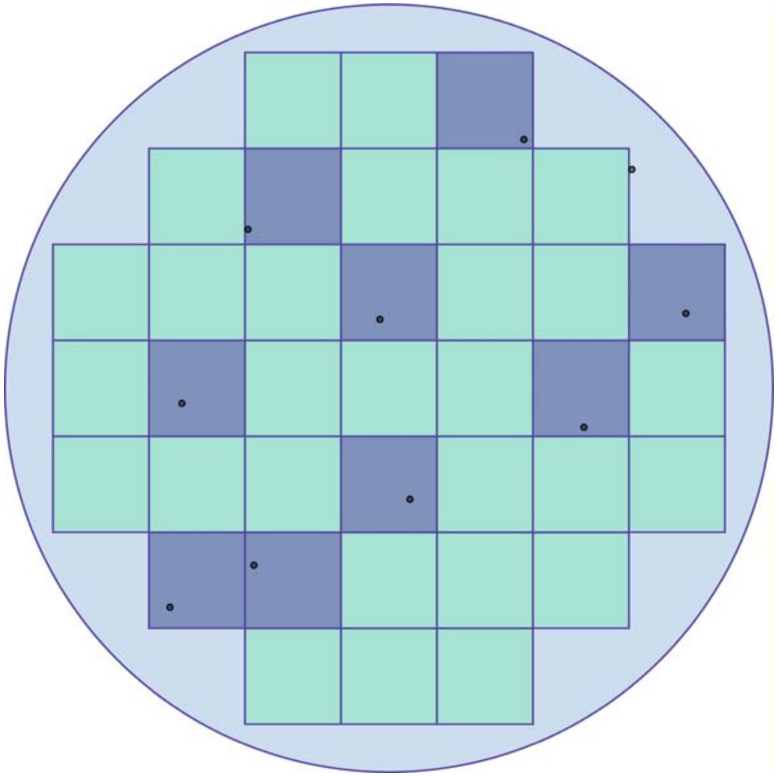
- Major trends affecting the microprocessor market
  - *Value PC*
  - *Value transistor*
  - *Emerging economies*
- Microprocessors
  - *Computer microprocessors*
  - *Embedded microprocessors*
  - *Configurable microprocessors*
  - *PLD microprocessors*

# Moore's Law

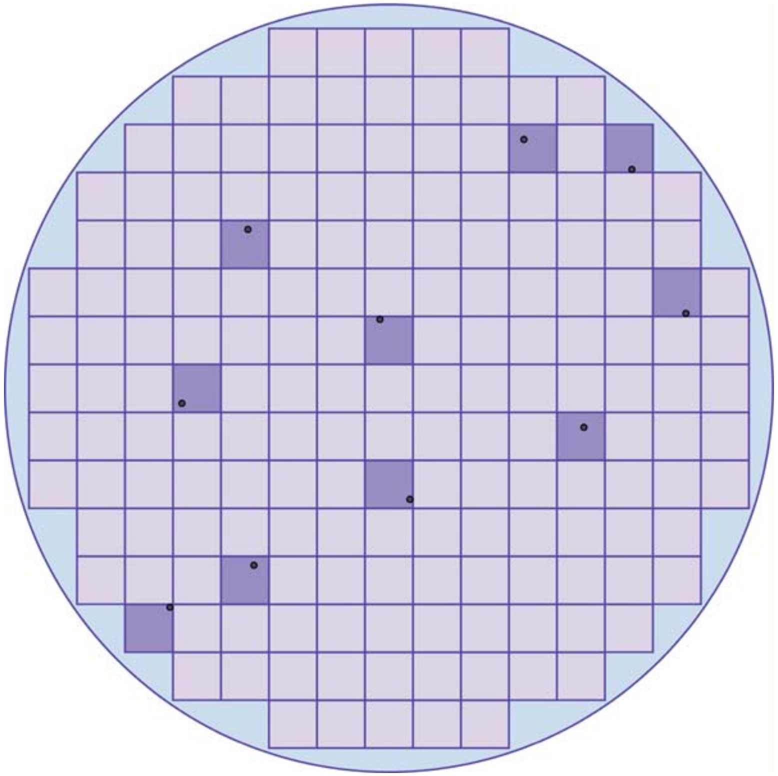


Relative Cost or
Relative Number of Transistors
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
Year
Cost of a transistor
Number of transistors
on a chip

# Moore’s Law: Wafer Yield



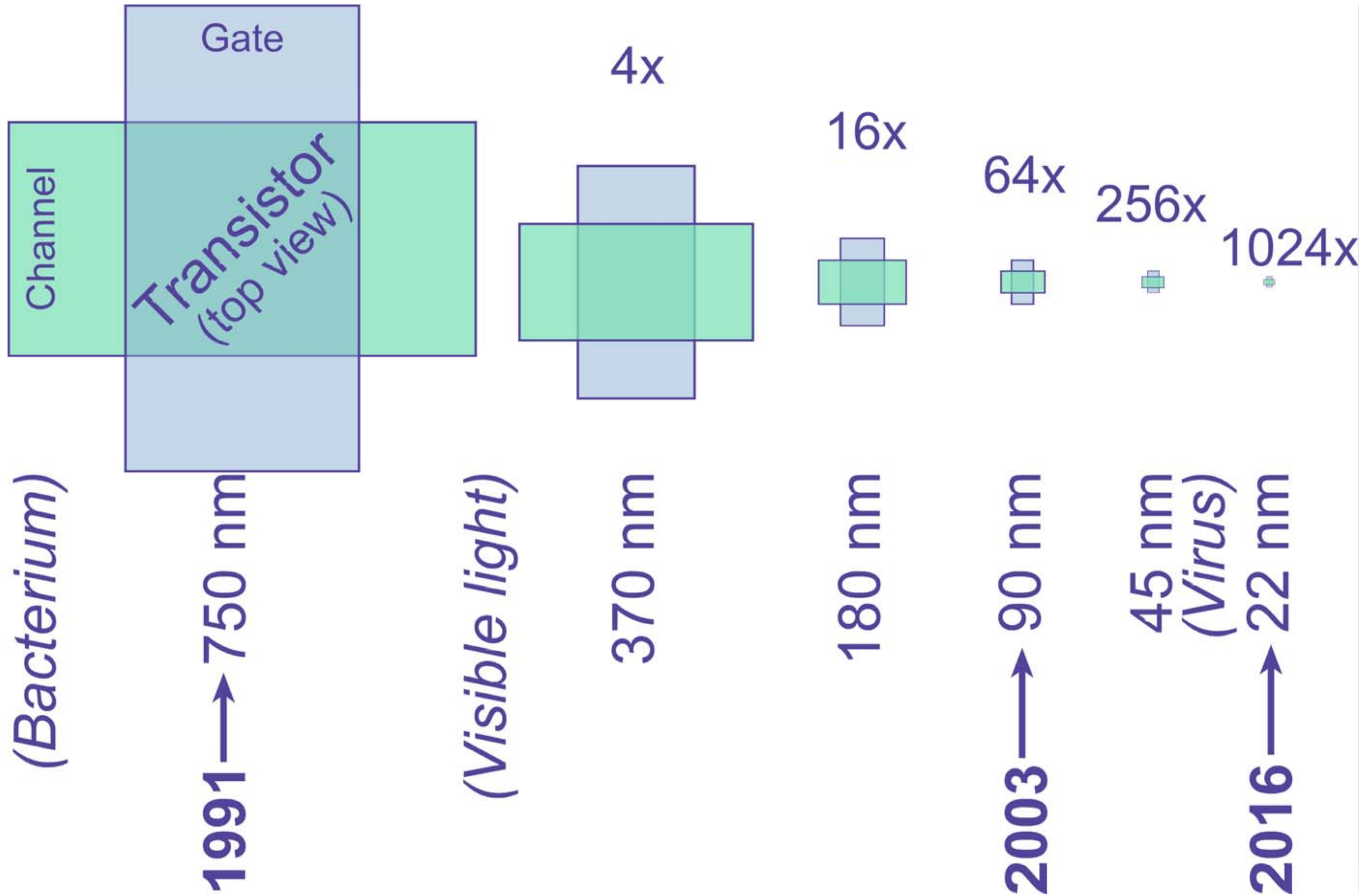
- 37 die/wafer
- 28 good die
- Yield: 75%



- 177 die/wafer
- 167 good die
- Yield: 94%

**Halving dimensions yields 6x good die!**

# Top View: Field-Effect Transistor



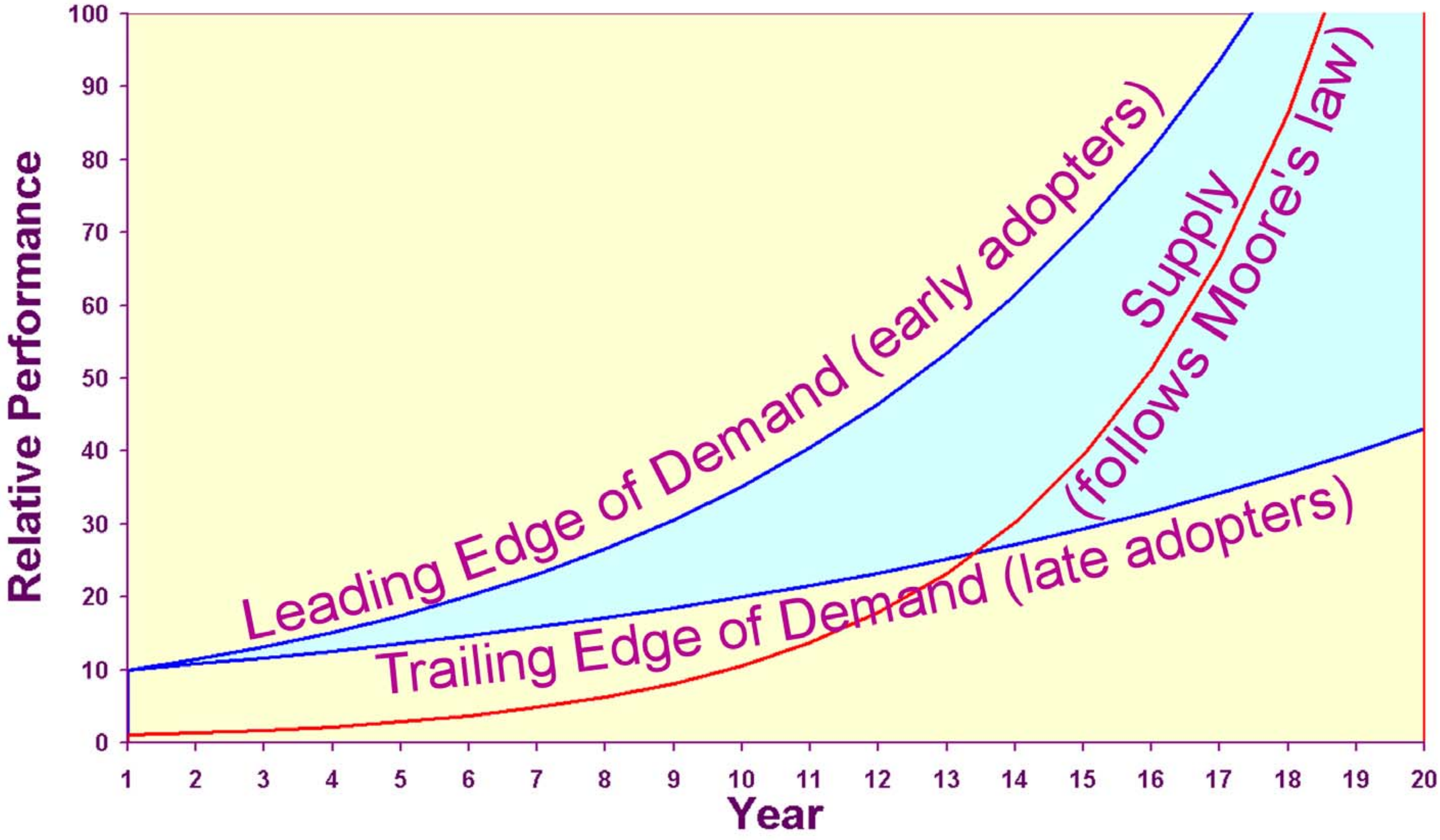
# The Microprocessor

- 10 years of Moore’s-law progress led to the microprocessor
- The second generic component
- Raised engineers’ productivity
- Problem-solving became programming
- Grew to billions of units/year
- Stalled progress in design methods for thirty years

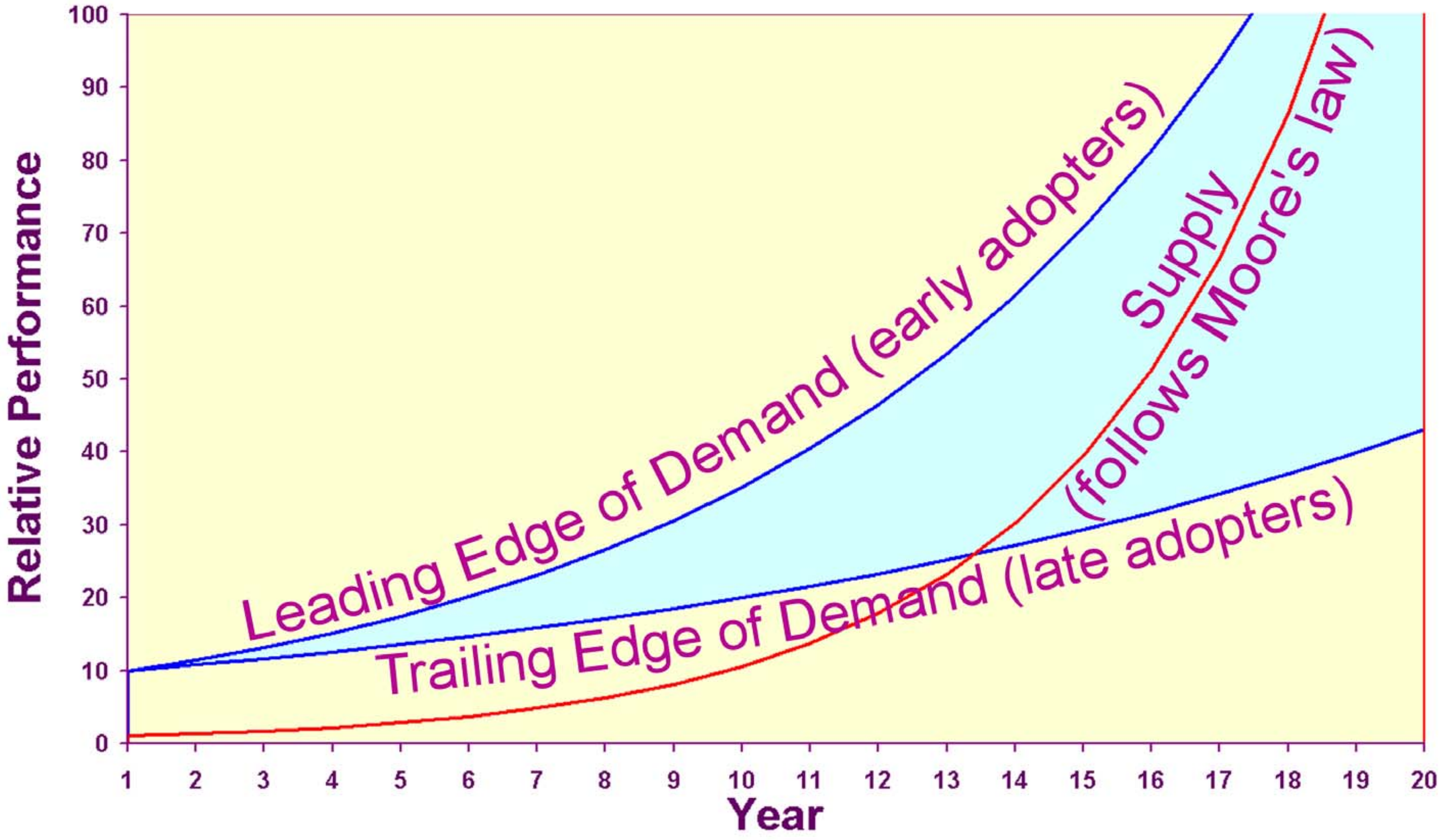
# The Personal Computer

- 10 years of microprocessor progress led to the PC
- Dominated the industry for 20 years
- Supply of performance grows with Moore’s law
- Demand grows more slowly
- Diverging growth in supply and demand leads to the value PC

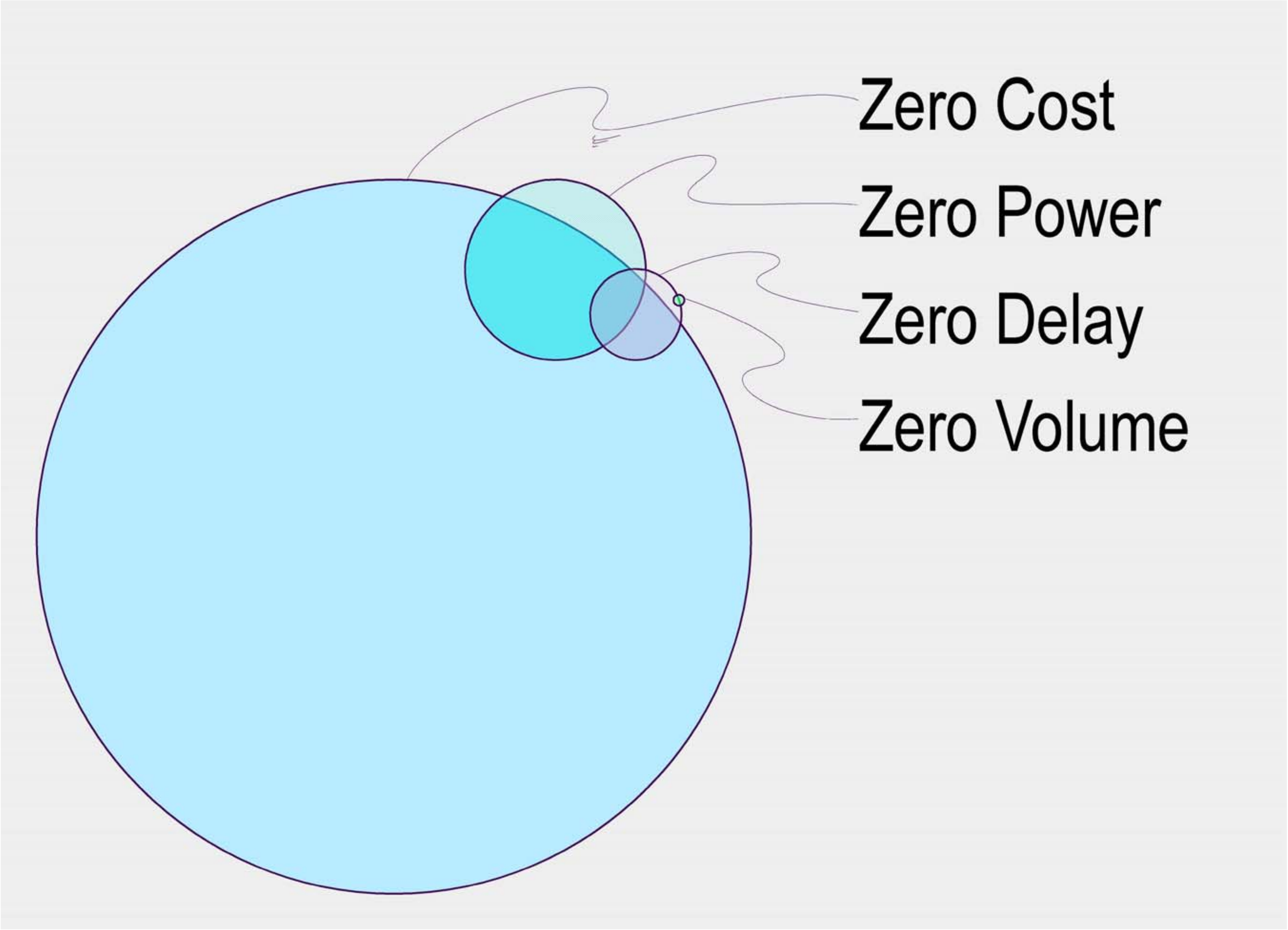
# The PC Is Good Enough



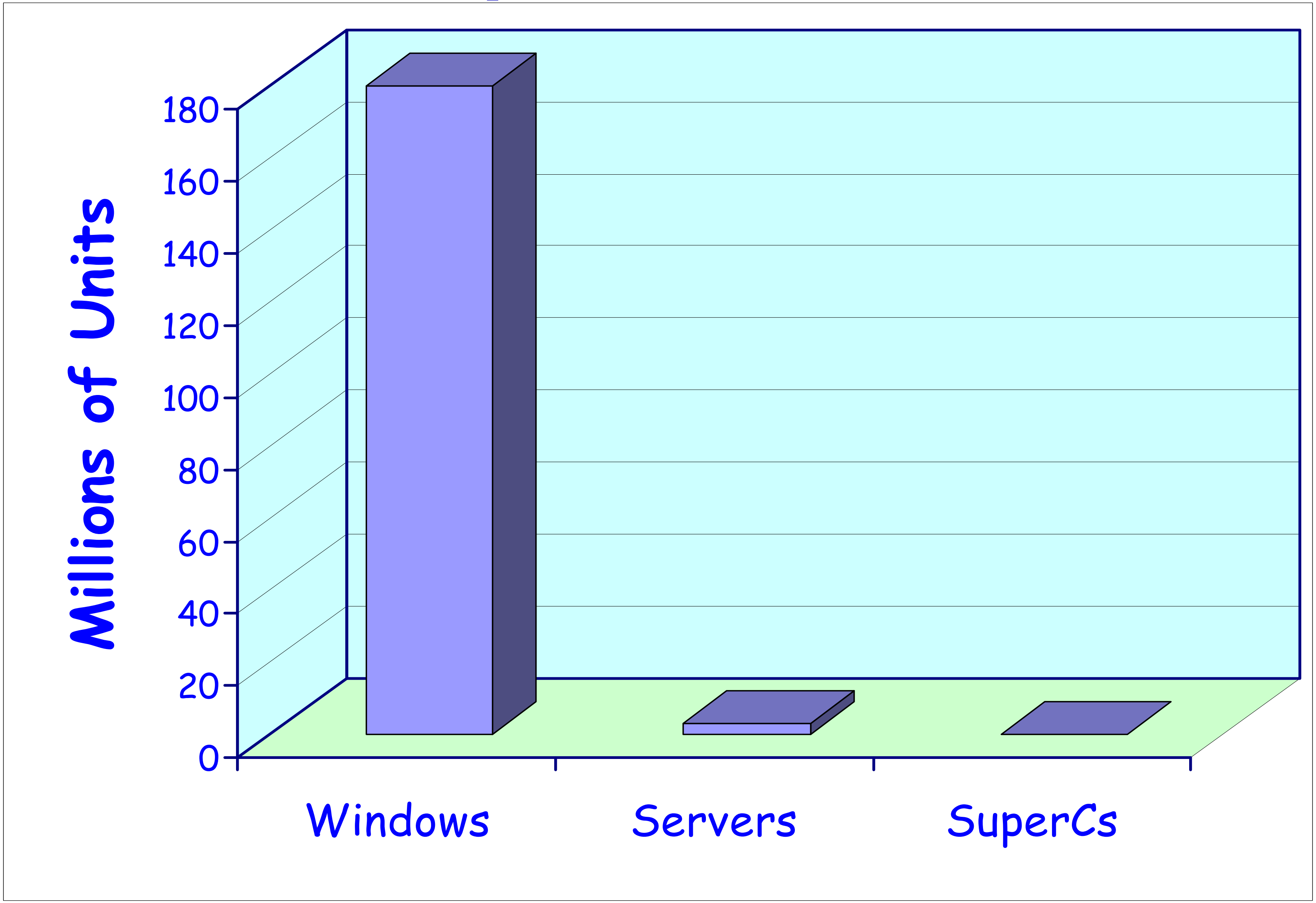
# The Path To The Value Transistor



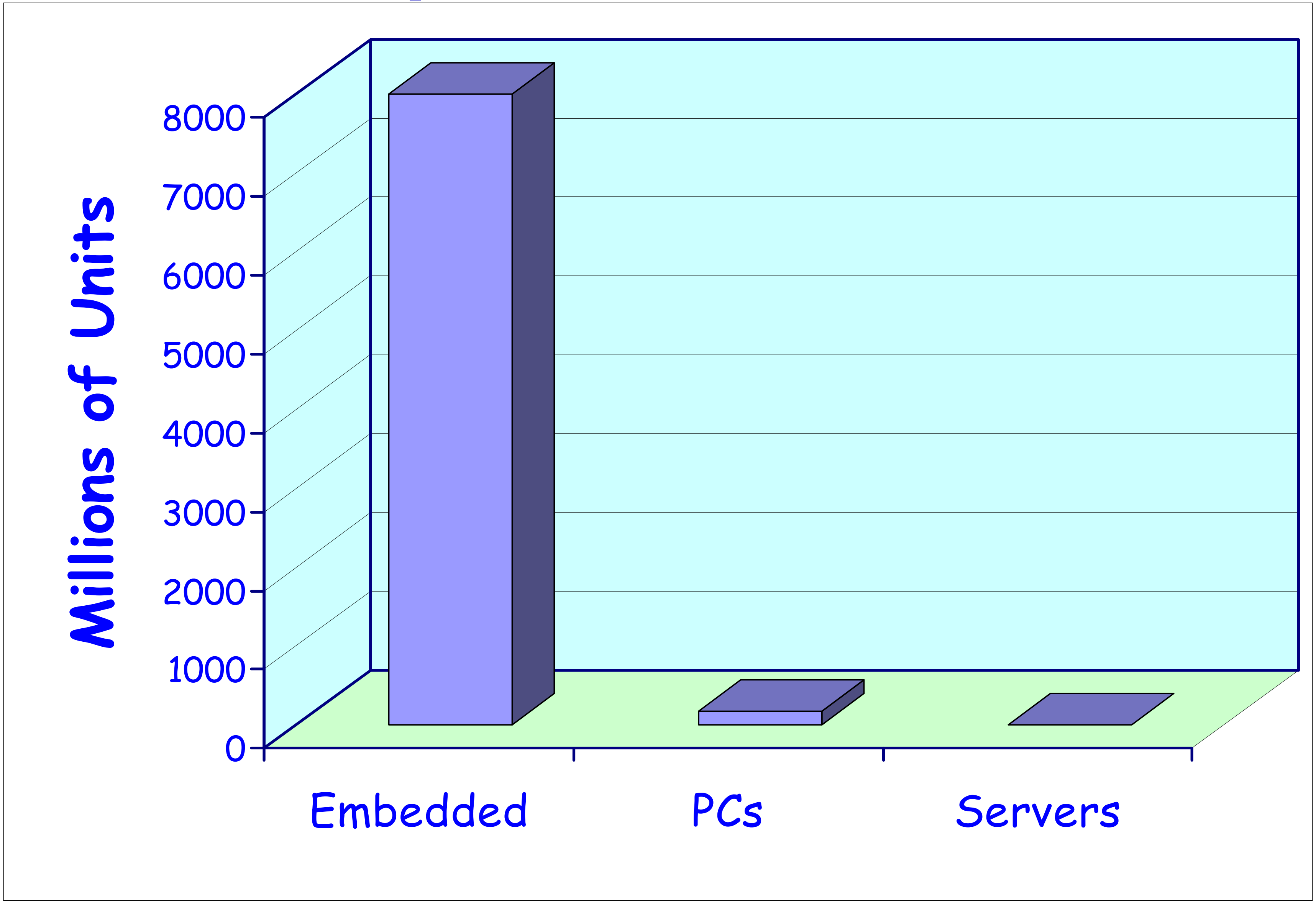
# Electronic Systems Market Segments



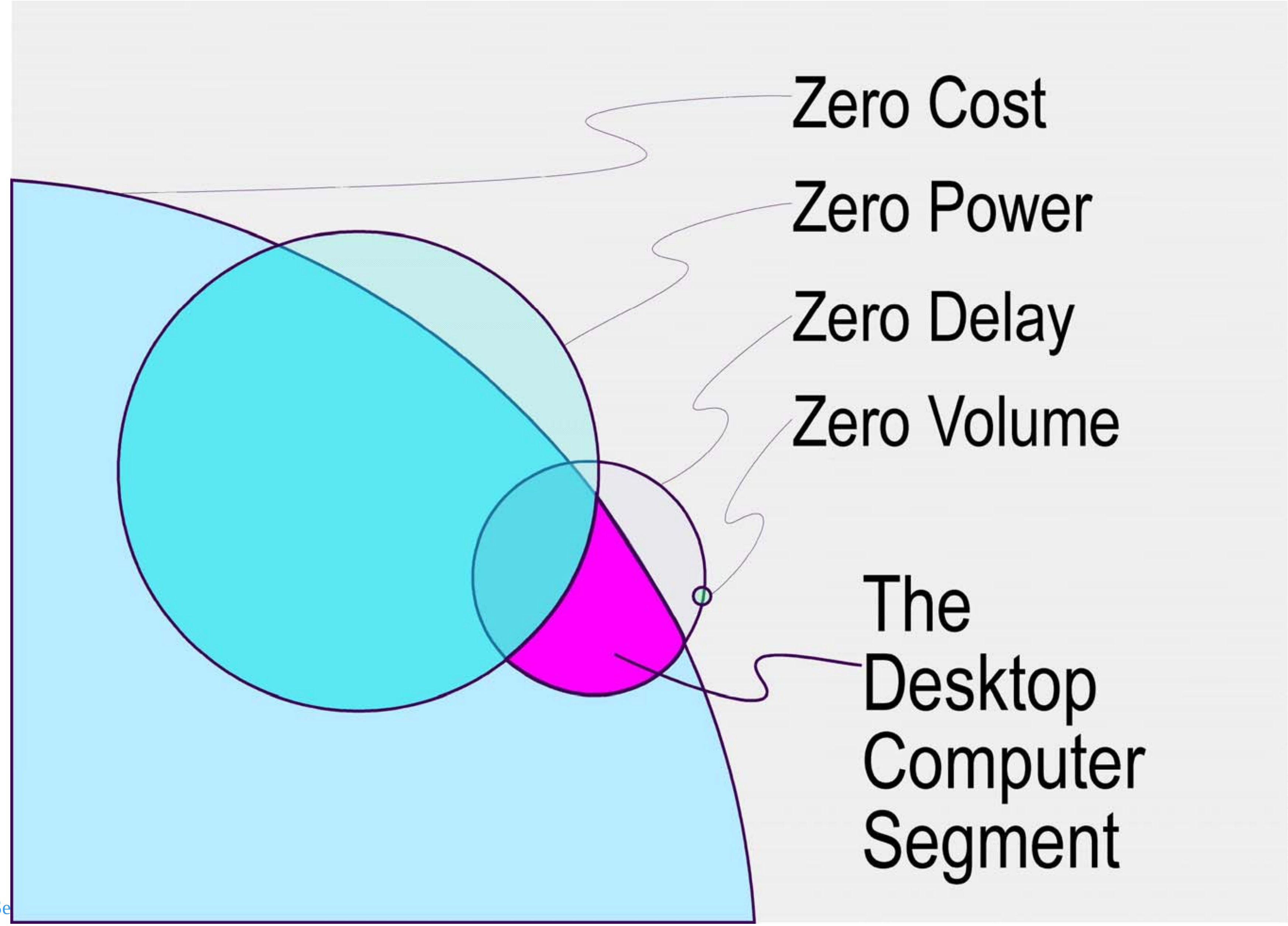
# Computer Markets



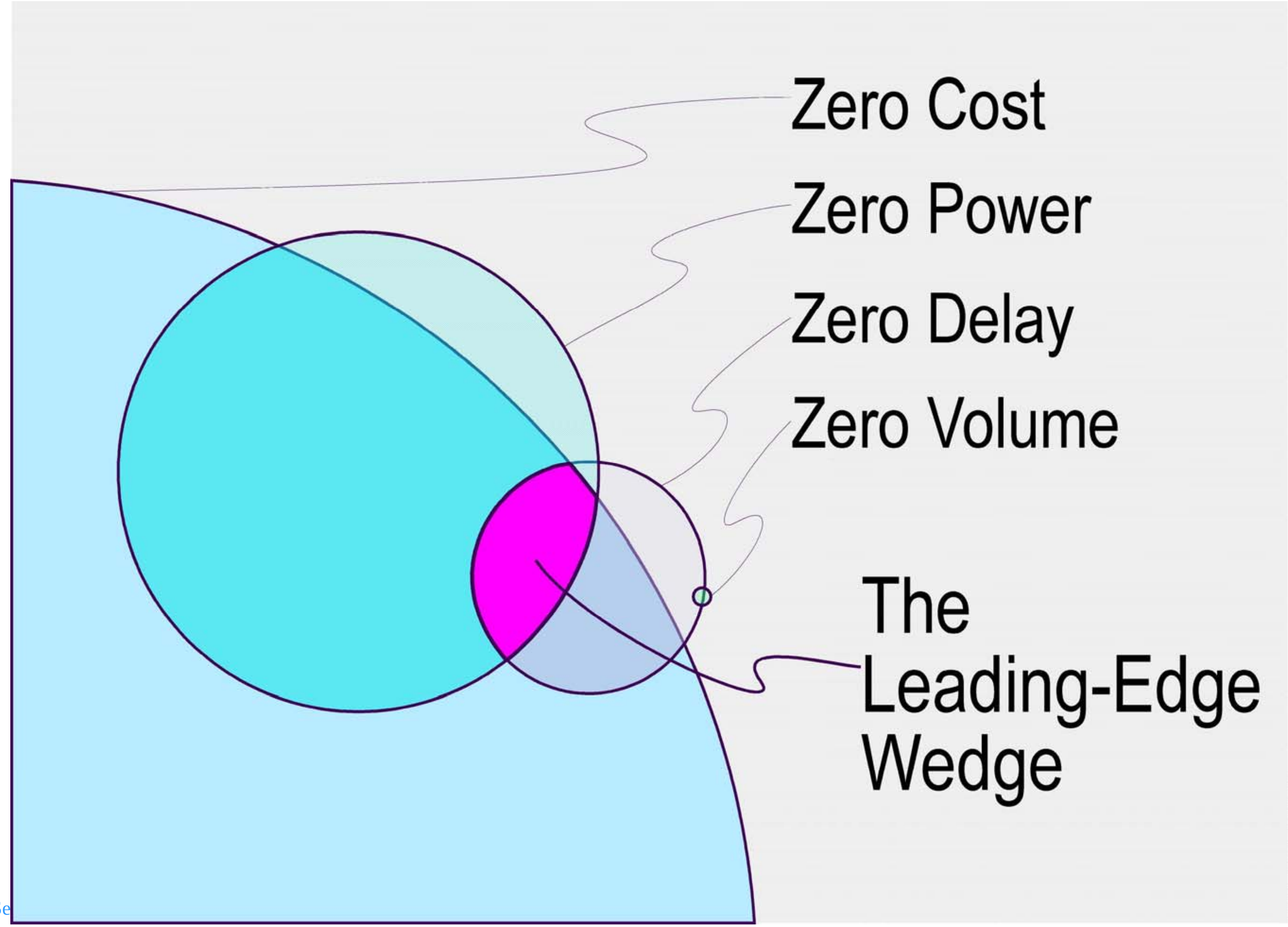
# Microprocessor Markets



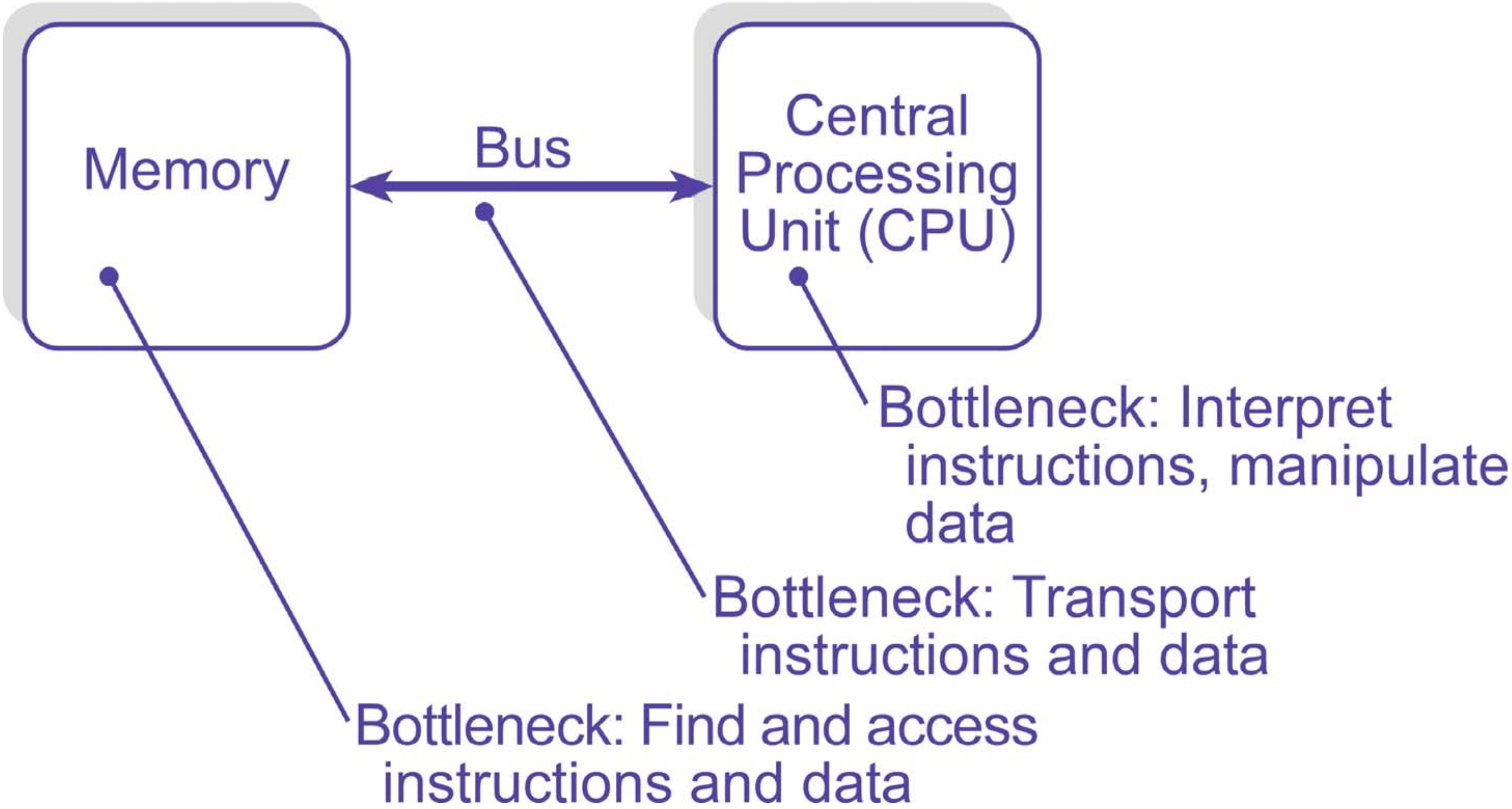
# The Cost-Performance Segment



# Cost-Performance-Per-Watt



# Microprocessors Are Unsuitable



# Programmers And Logic Designers

The Users Manual is the (problematic) bridge

- Programmers optimize software
  - *Languages*
  - *OS*
  - *Compilers*
  - *Applications*

Programmers

- Logic designers optimize hardware
  - *Microprocessors*
  - *Memory*

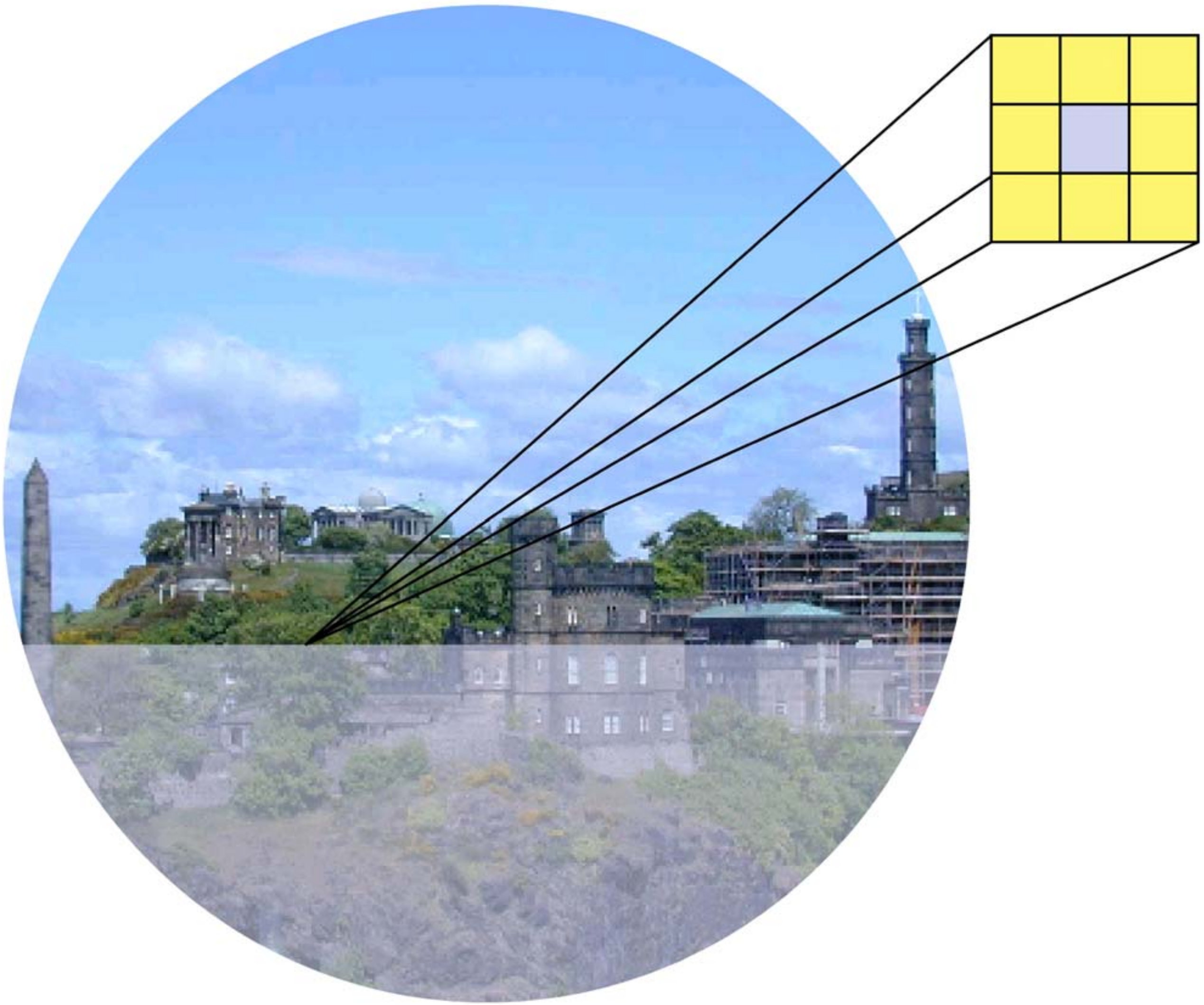
Logic designers

# Scenic View

# Scenic View in Fog

# Scenic View with Lens

# Scenic View and Photoshop



# Microprocessors and ASICs

Application

Microprocessor

- For the ultimate in flexibility, programmers map the application onto a general-purpose microprocessor.

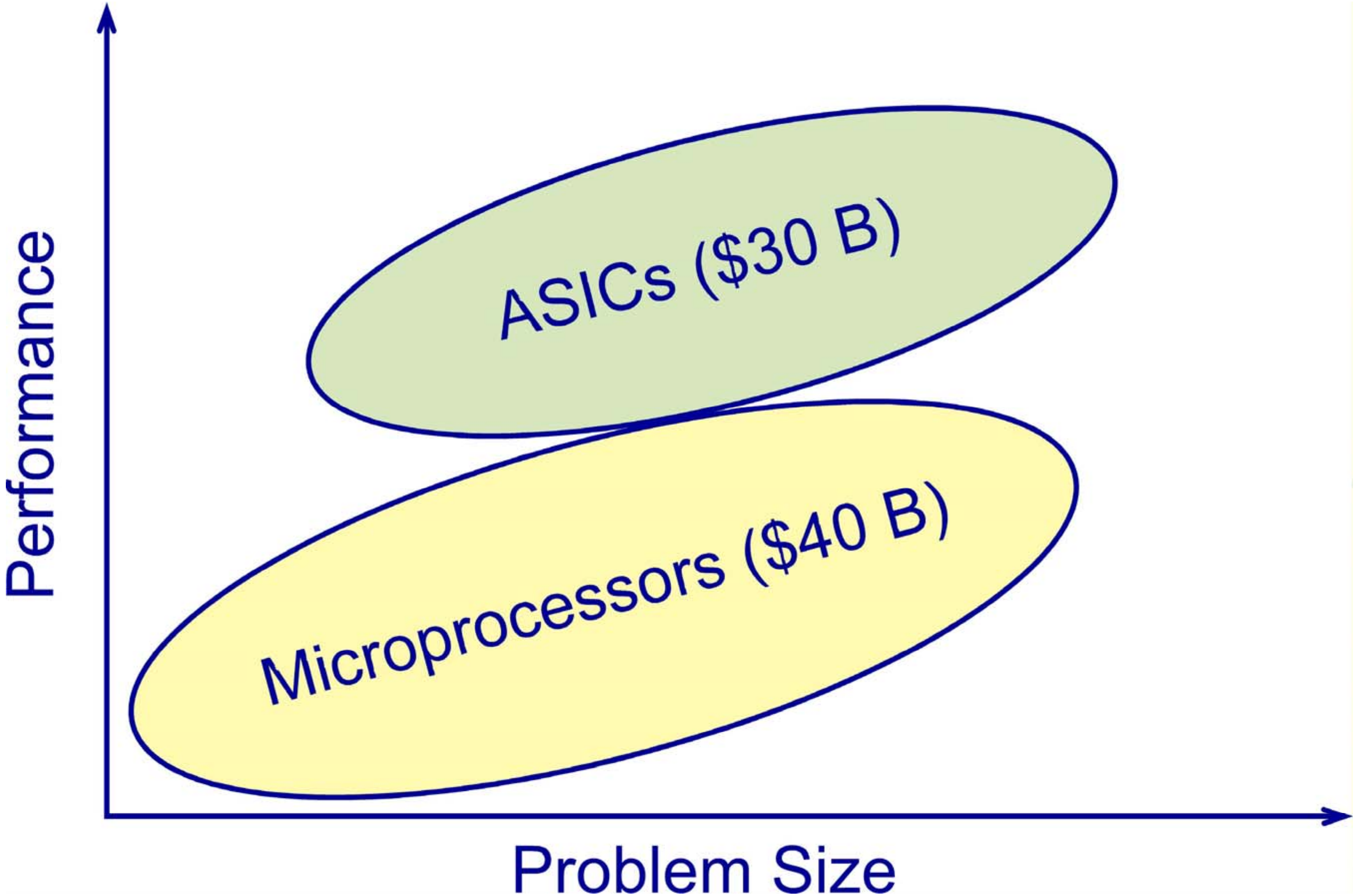
Programmers

- For the ultimate in performance, logic designers map the application into a custom circuit.

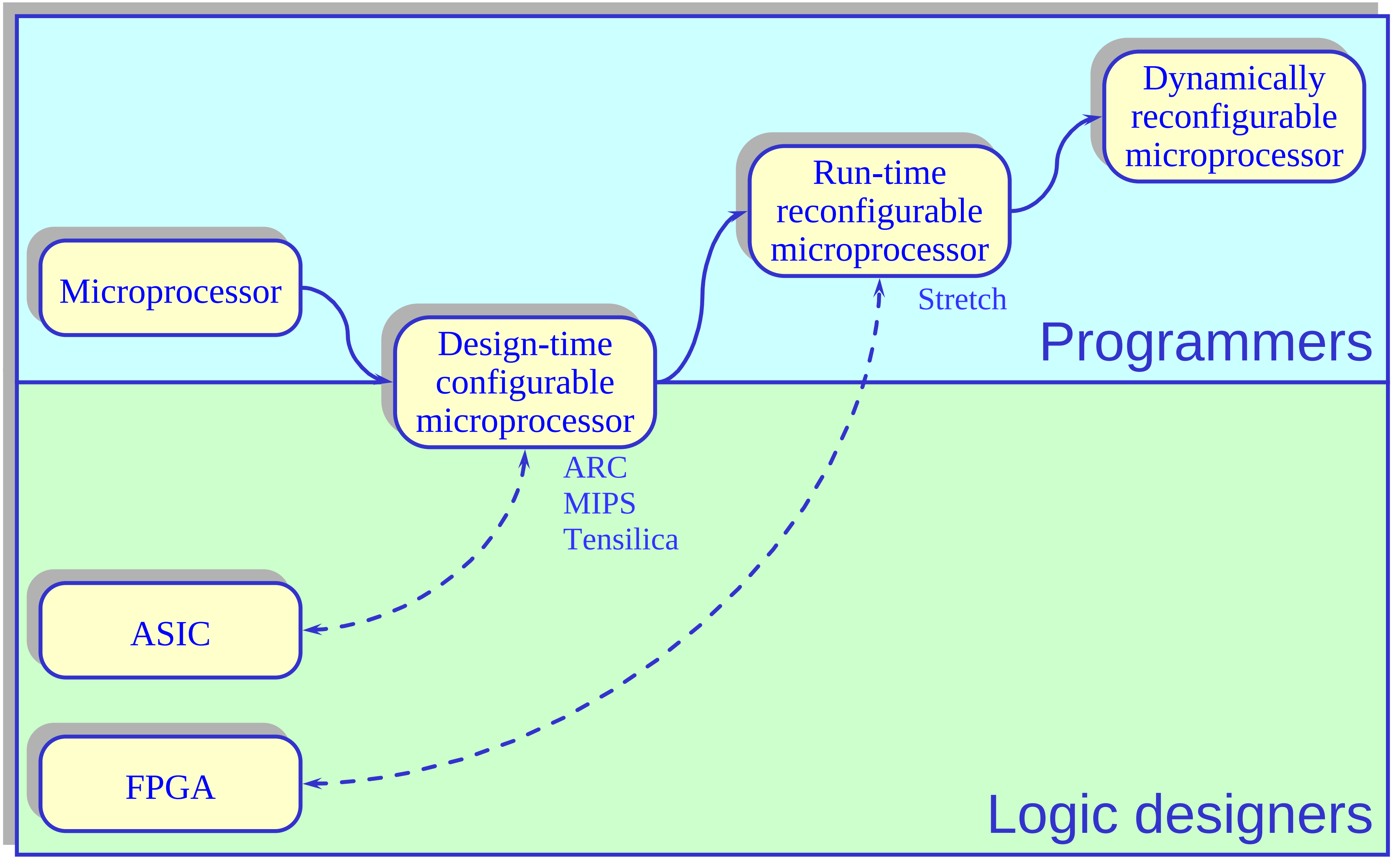
ASIC

Logic designers

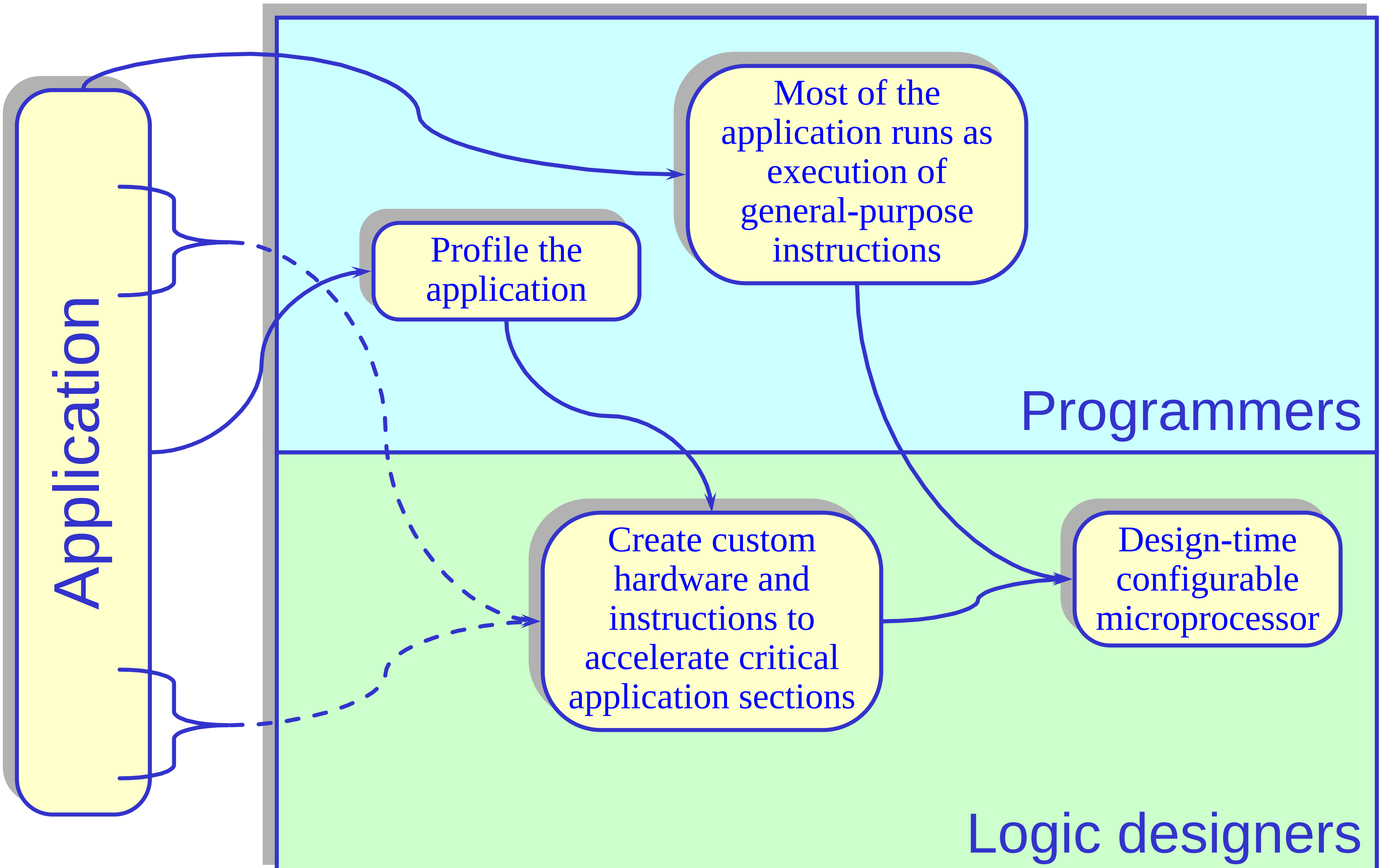
# ASICs & Microprocessors



# Microprocessor Evolution



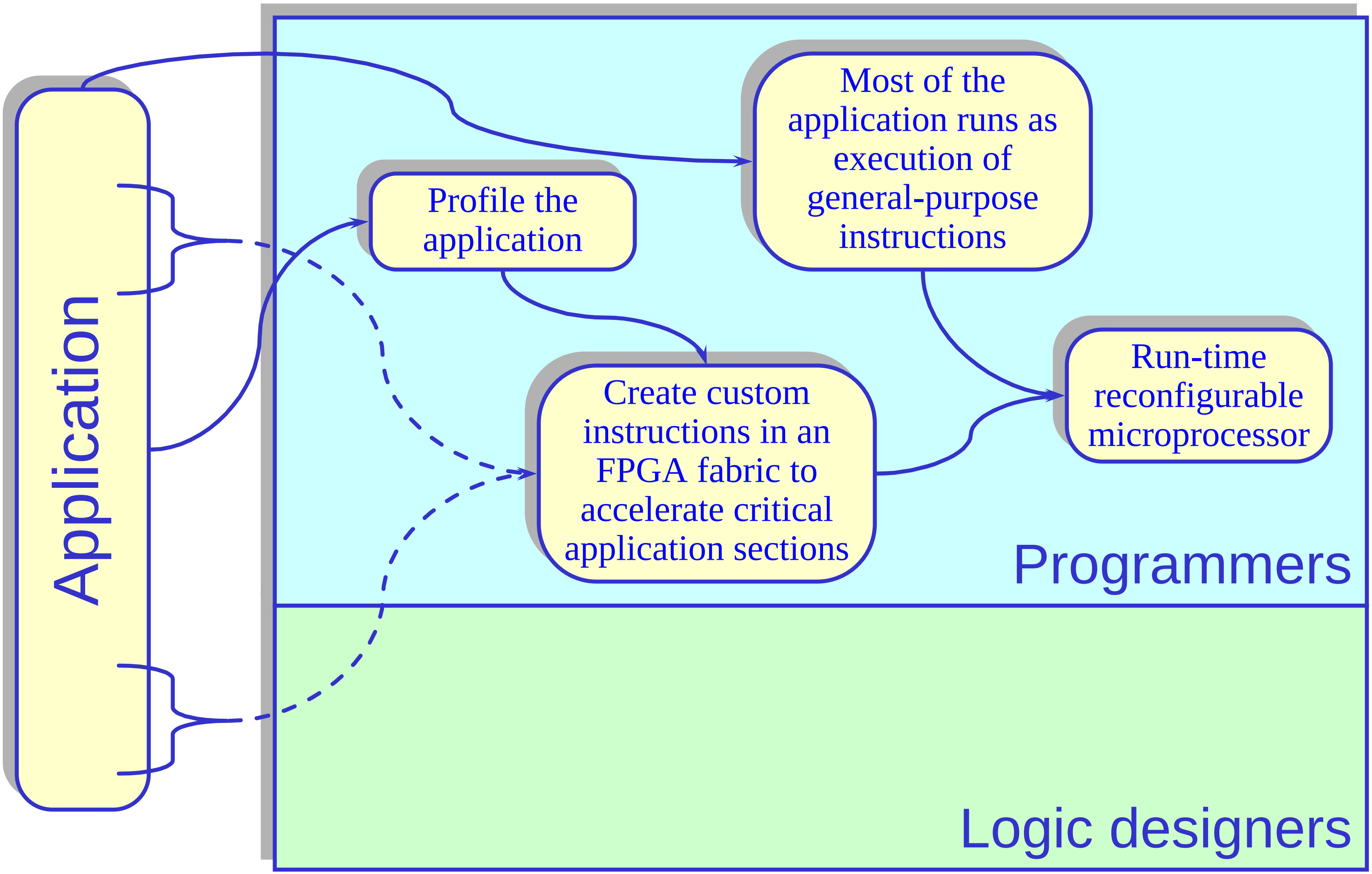
# Design-Time Configurable Microprocessor



# Design-Time Configurable Microprocessor

- Profile the application
- Create custom instructions for critical code sections
- Build specialized execution units
- Can be 10 to100 times faster than a general-purpose microprocessor on the target algorithm
- Examples: ARC and Tensilica
- Customized microprocessor limitations
  - *Requires logic designers*
  - *Creates an application-specific, limited-function microprocessor*
  - *Accelerates only critical sections*

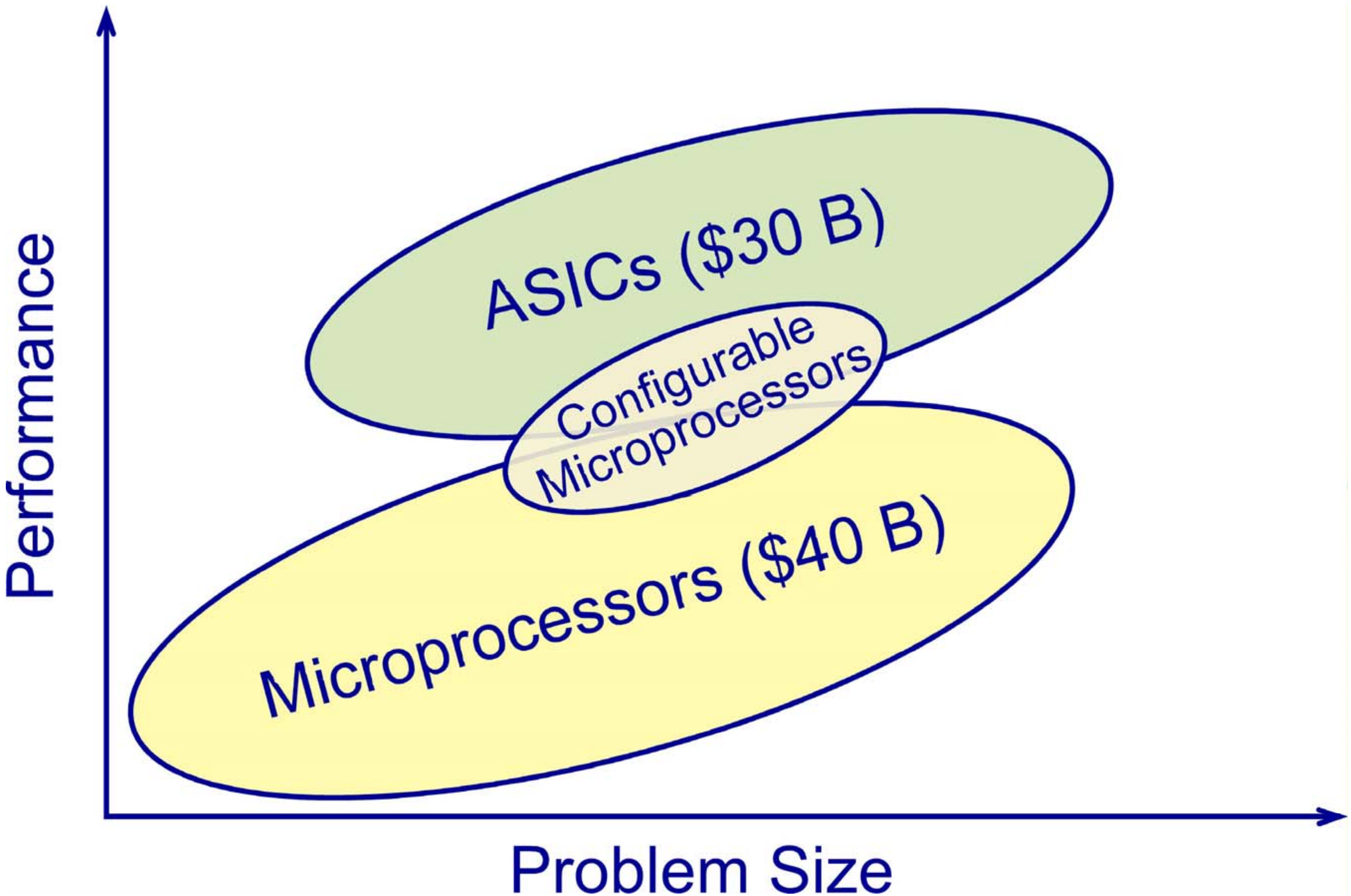
# Run-Time Reconfigurable Microprocessor



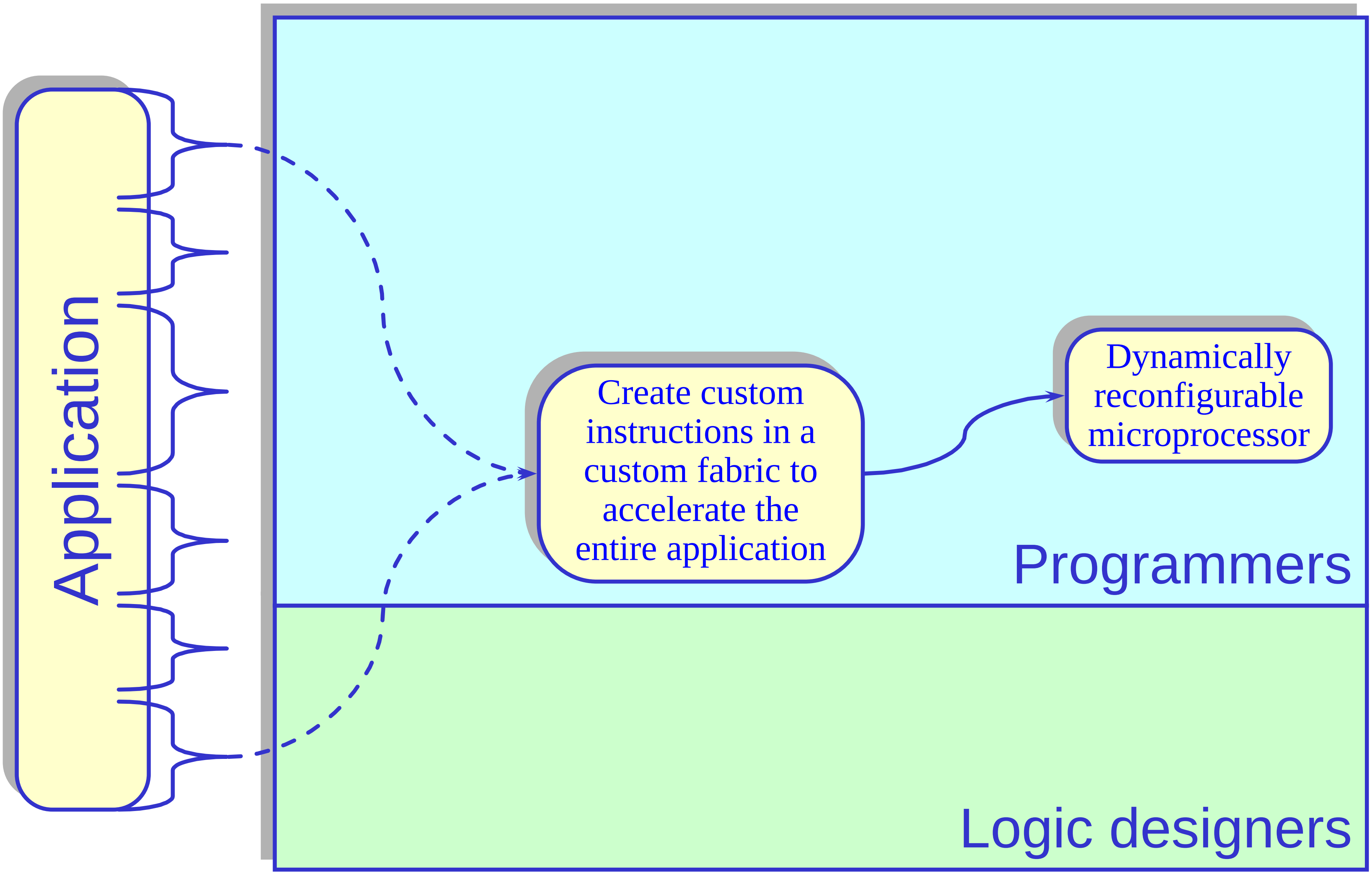
# Run-Time Reconfigurable Microprocessor

- Build a general-purpose microprocessor with integrated FPGA fabric
- Profile the application
- Create custom instructions for critical code sections
- Build custom execution units in FPGA fabric
- Can be 10 to 100 times faster than a general-purpose microprocessor on the target application
- Example: Stretch
- Run-time reconfigurable microprocessor limitations
  - *Accelerates only statically identifiable critical sections*
  - *Limited to problems for which profiling works*
  - *Profiling is difficult*

# ASICs & Microprocessors



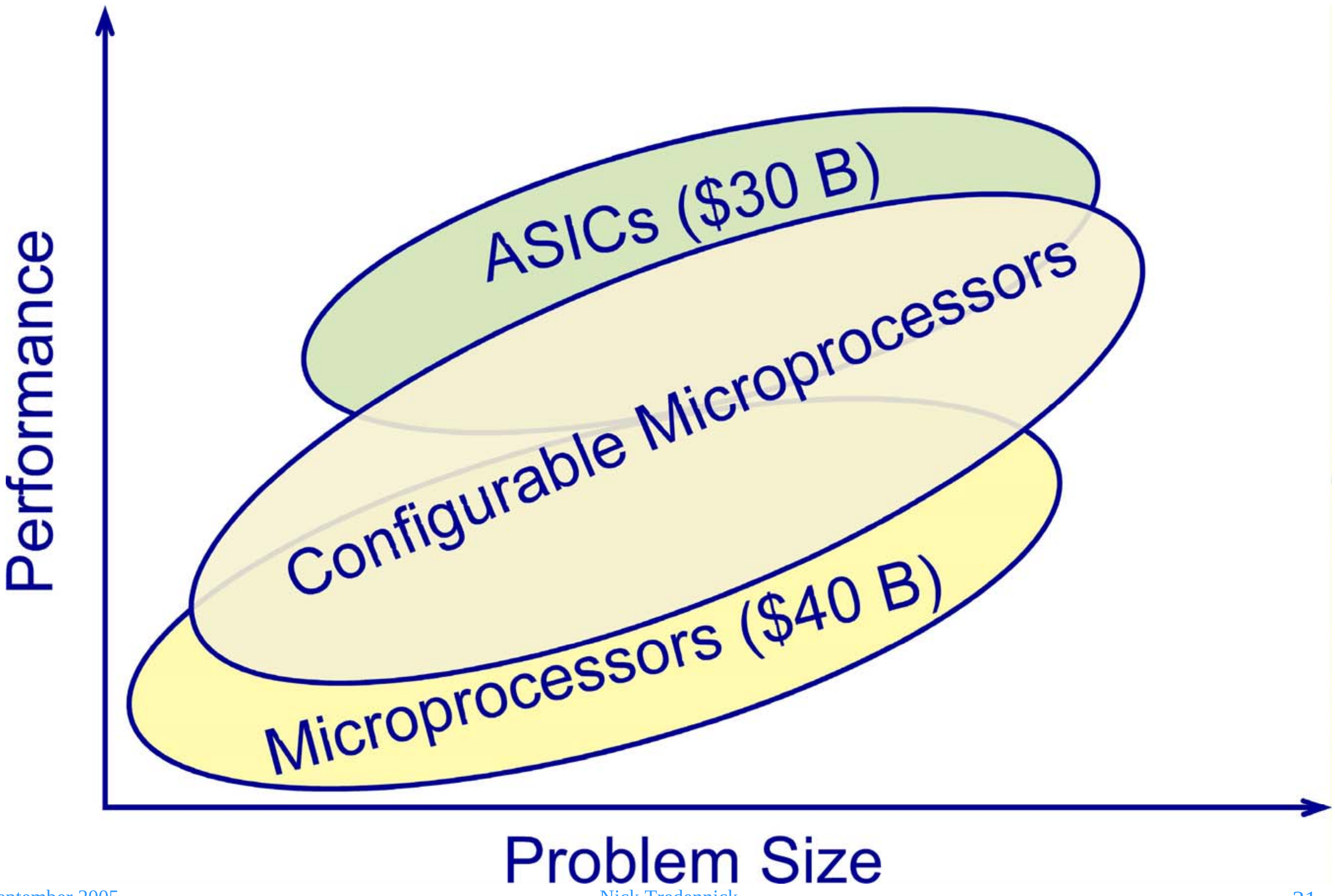
# Dynamically Reconfigurable Microprocessor



# Dynamically Reconfigurable Microprocessor

- Each cycle creates a new microprocessor implementation
  - *Each cycle creates a custom circuit (Ascenium instruction) representing hundreds to thousands of conventional instructions*
- Programmed using ANSI-standard programming languages (e.g., C/C++)
- Tens to 100s of times faster than a general-purpose microprocessor
- Dynamically reconfigurable microprocessor limitations
  - *There are none on the market today*
    - Until Ascenium, no one has figured out how to “program” a dynamically reconfigurable circuit
  - *VCs don’t understand it*

# Reconfigurable Systems Emerge

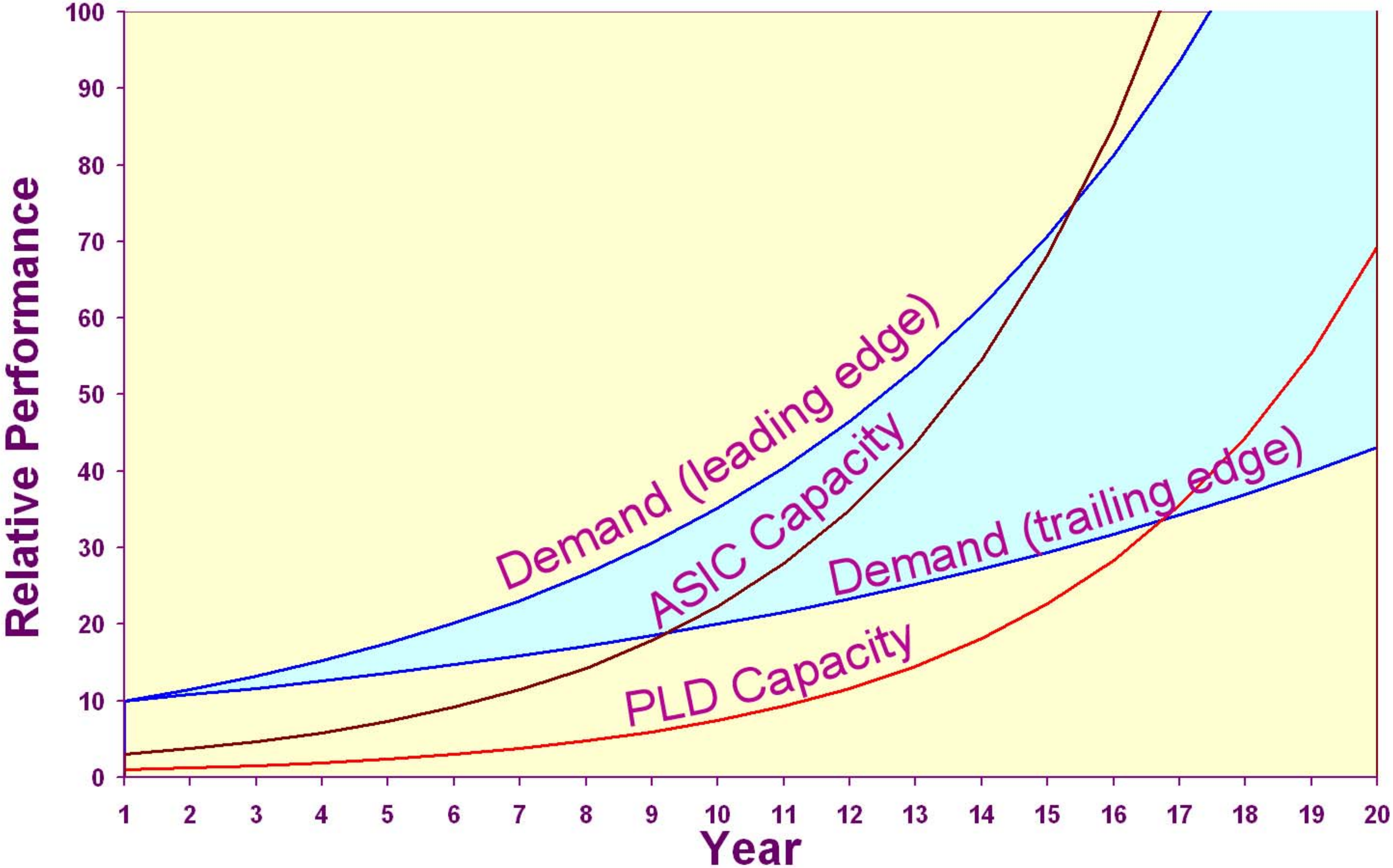


# Situation

| What | Value | Who |
|---|---|---|
| • PLDs | $3B | logic designers |
| • ASICs | $30B | logic designers |
| • Microprocessors | $40B | programmers |

PLDs and microprocessors are usurping a declining ASIC market.
Microprocessors (and their derivatives) will win.

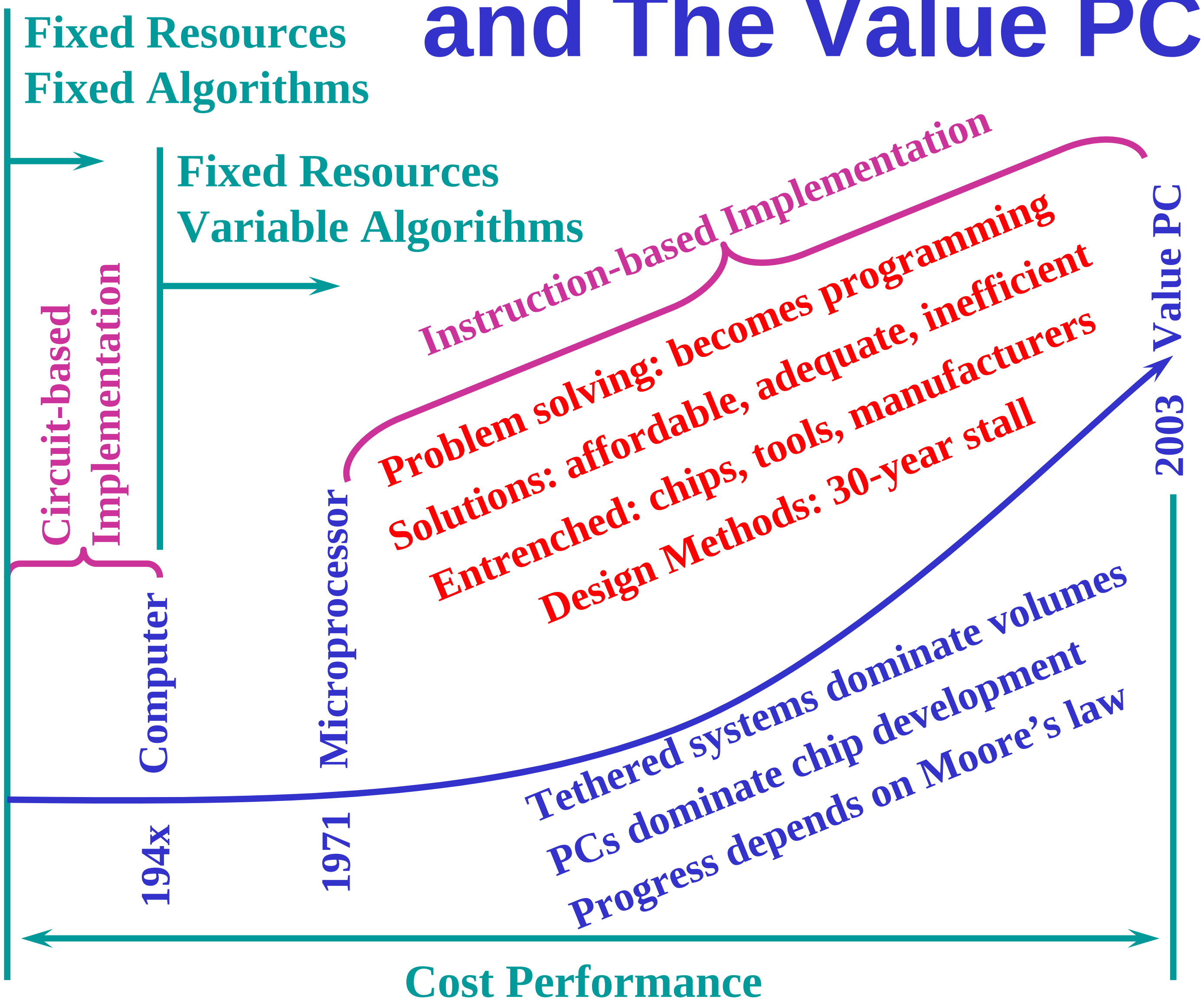
# Supply and Demand: ASICs & PLDs



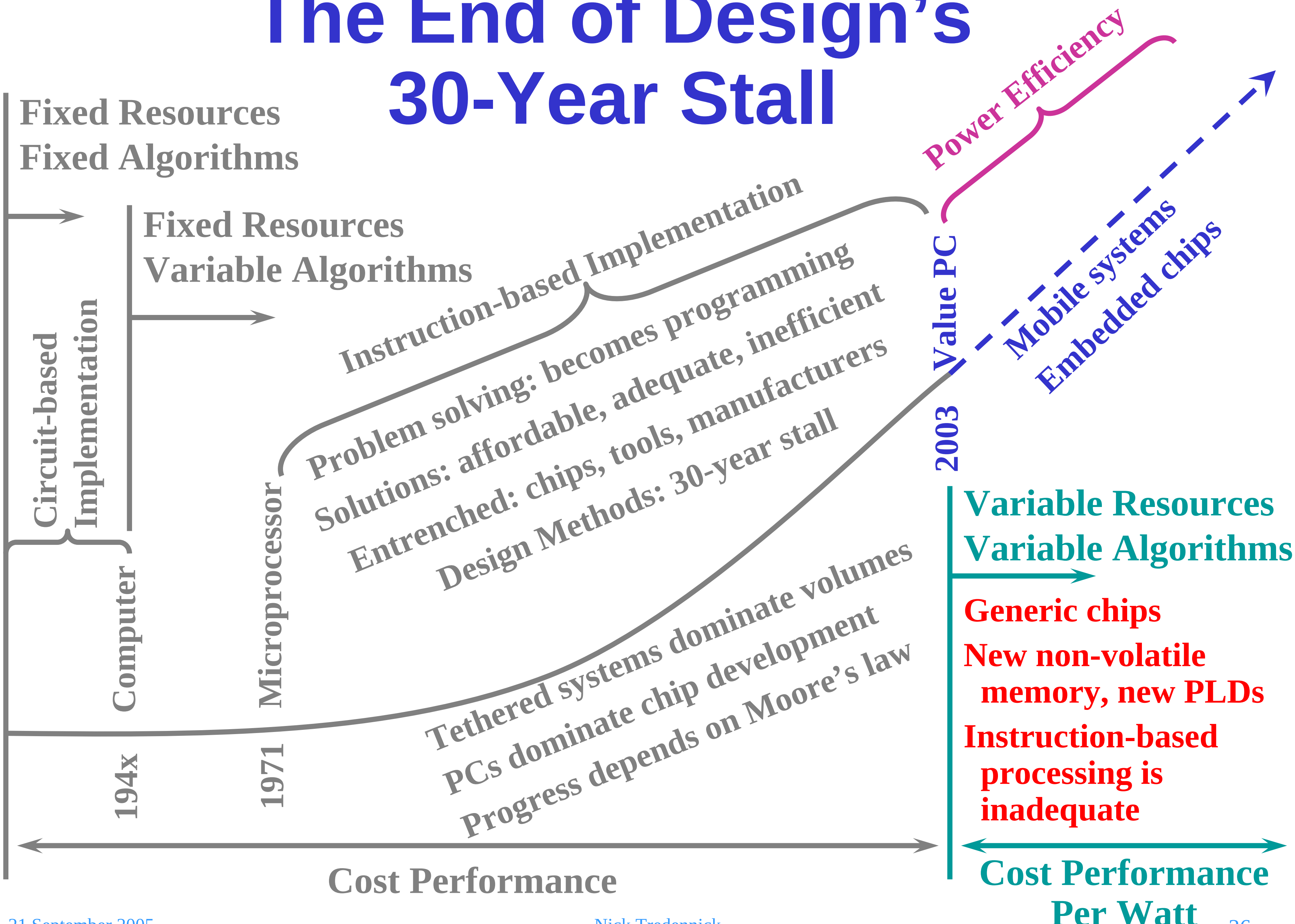
# *Battles are fought at the leading edge; the war goes to what is good enough.*

- RISC vs. CISC
  - *Proving you <u>can</u> build a career on smoke and mirrors*
- Assembler vs. High-level language
- Workstations vs. PCs
  - *Build for volume and performance follows; build for performance and languish*
- ASICs vs. PLDs

# Semiconductor Development and The Value PC



# The End of Design's 30-Year Stall



# Consequences

- Rise of mobile applications
  - *New non-volatile memories*
- Rise of foundries
  - *Rise of soft (IP) cores*
  - *Horizontal fragmentation of integrated device manufacturers*
- Rise of non-volatile PLDs
- Rise of reconfigurable systems
- Growing market for embedded microprocessors
  - *Tethered: traditional role*
  - *Mobile: supervisory role*

# Microprocessors

| | |
|---|---|
| • x86 | AMD, Intel, Via |
| • ARC | ARC |
| • ARM | ARM |
| • MicroBlaze | Xilinx |
| • MIPS | MIPS |
| • Nios | Altera |
| • PowerPC | IBM, Freescale |
| • SPARC | Sun |
| • Tensilica | Stretch, Tensilica |
| • Old stuff | Everyone |

# Microprocessor Applications

- Supercomputers
- Workstations and servers
- PCs
- Embedded systems
  - *Automobiles*
  - *Cameras*
  - *Cell phones*
  - *Game players*
  - *MP3 players*
  - *Set-top boxes*

# Computer Microprocessors

- x86
  - *AMD*
  - *Intel*
  - *Via*
- Proprietary
  - *IBM*
  - *Freescale*
  - *Sun*

# Embedded Microprocessors

- Microprocessor advantages
  - *Flexibility*
  - *High-volume production*
  - *Usable by programmers*
- Microprocessor limitations
  - *Too slow*
  - *Too much power*

# Embedded Microprocessors

| | |
|---|---|
| • x86 | AMD, Intel, Via |
| • ARM | ARM |
| • PowerPC | IBM, Freescale |
| • Old stuff | Everyone |

  – *Triscend (Xilinx)*

# Configurable Microprocessors

| | |
|---|---|
| • ARC | ARC |
| • Ascenium | Ascenium |
| • MIPS | MIPS |
| • Nios | Altera |
| • Tensilica | Stretch, Tensilica |

# PLD Microprocessors

- Altera
  - *Nios (soft)*
- Xilinx
  - *MicroBlaze (soft)*
  - *PicoBlaze (soft)*
  - *PowerPC (hard)*