IT Industry Power Supply Technology and Skill Requirements

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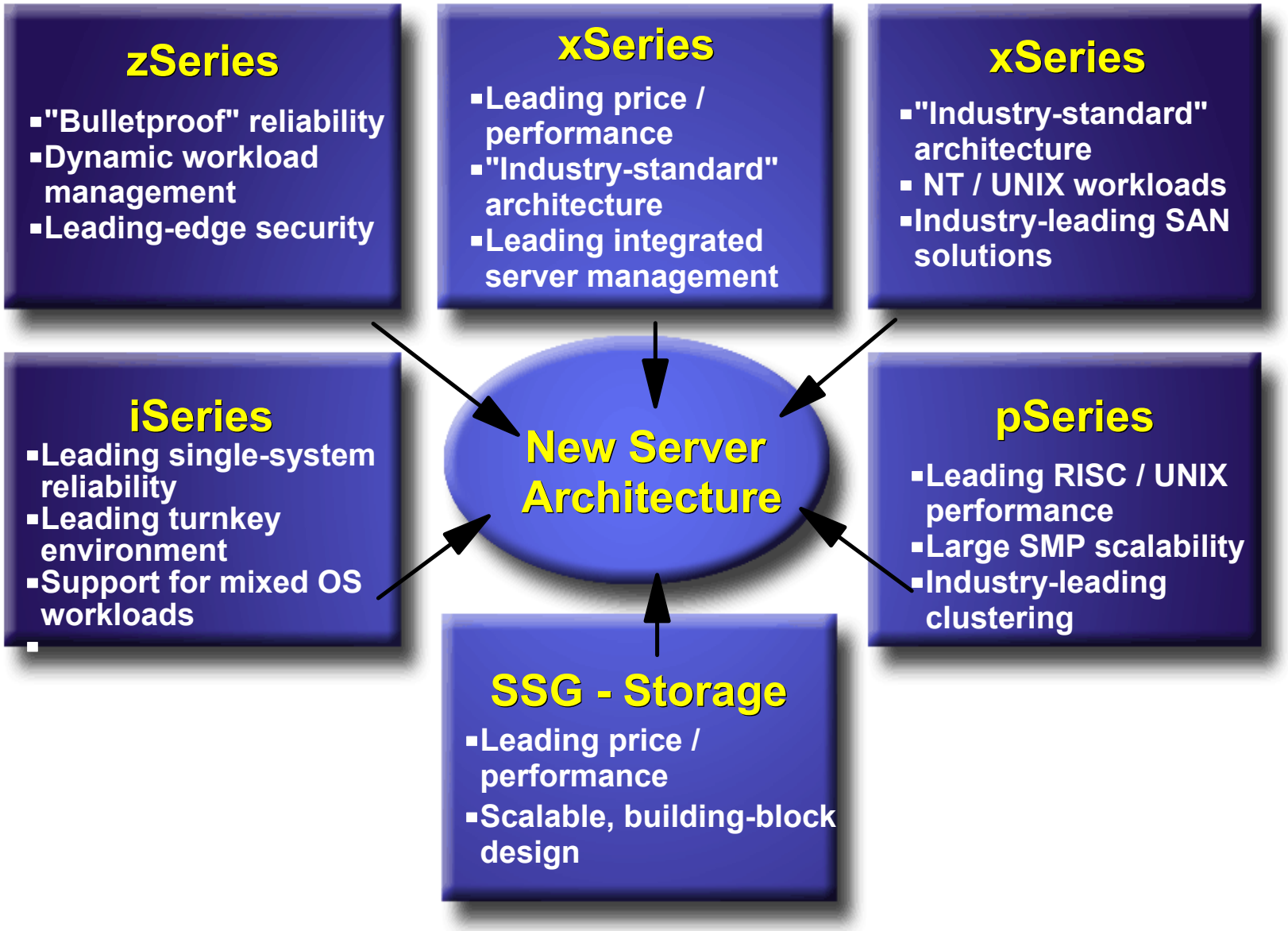
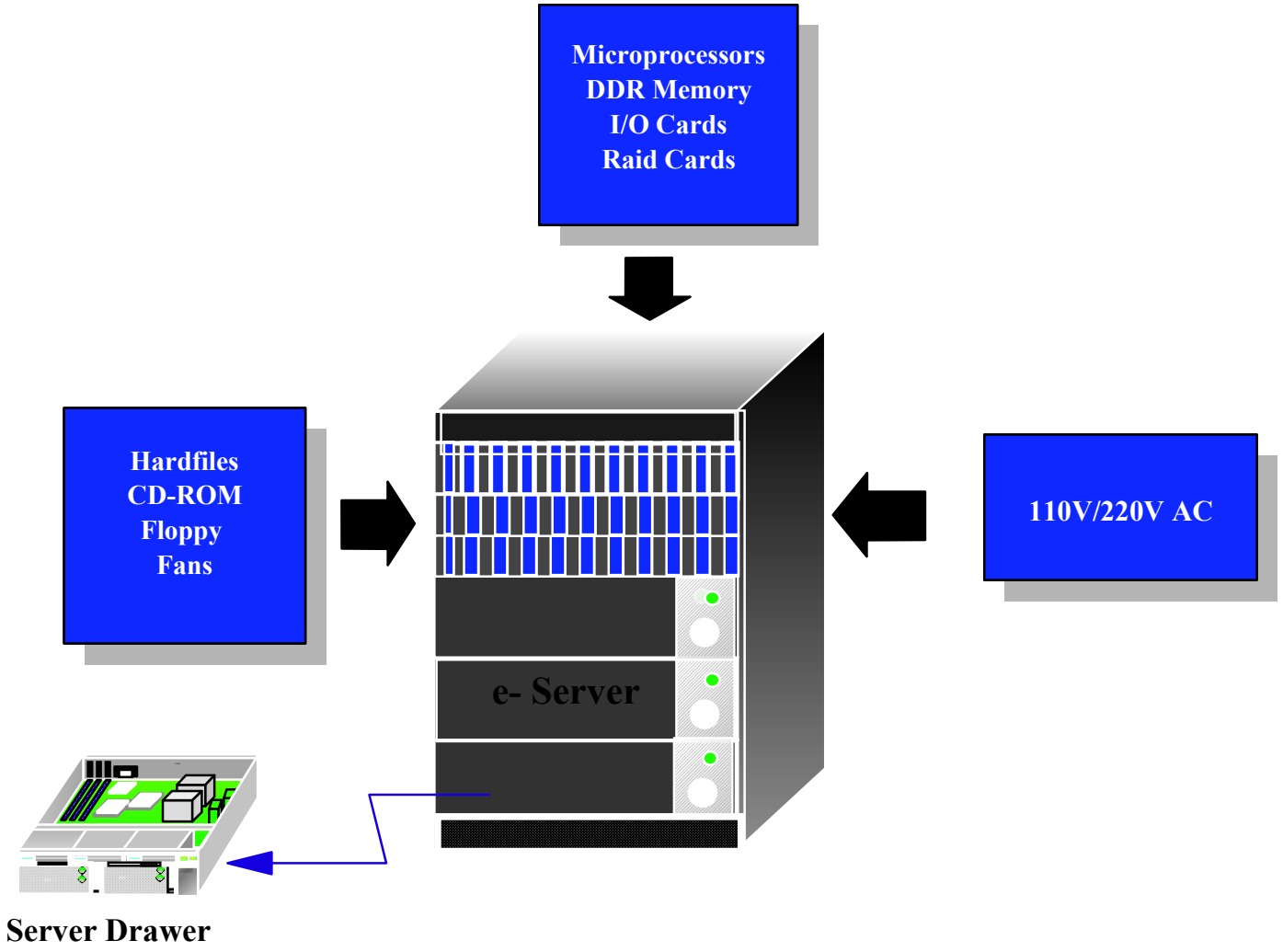
IBM

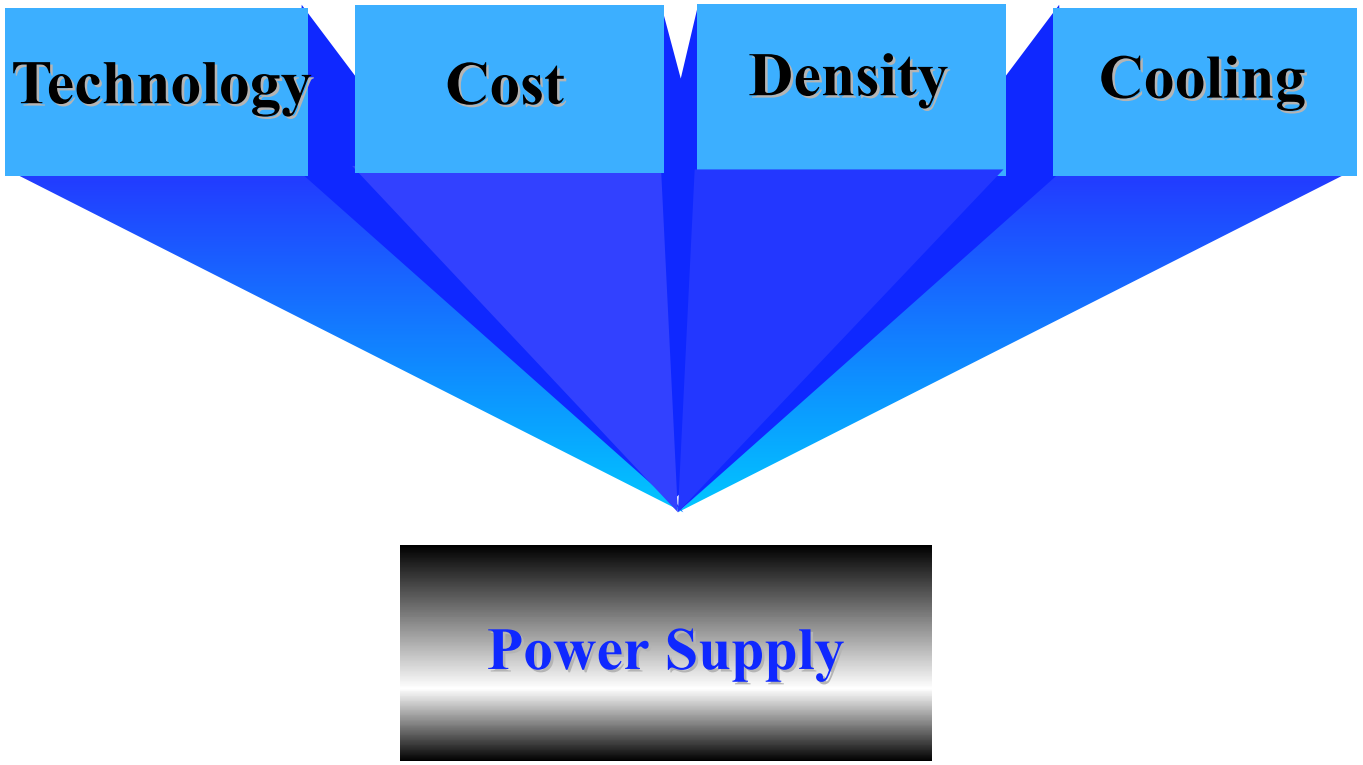
IBM Servers: Hardware Integration



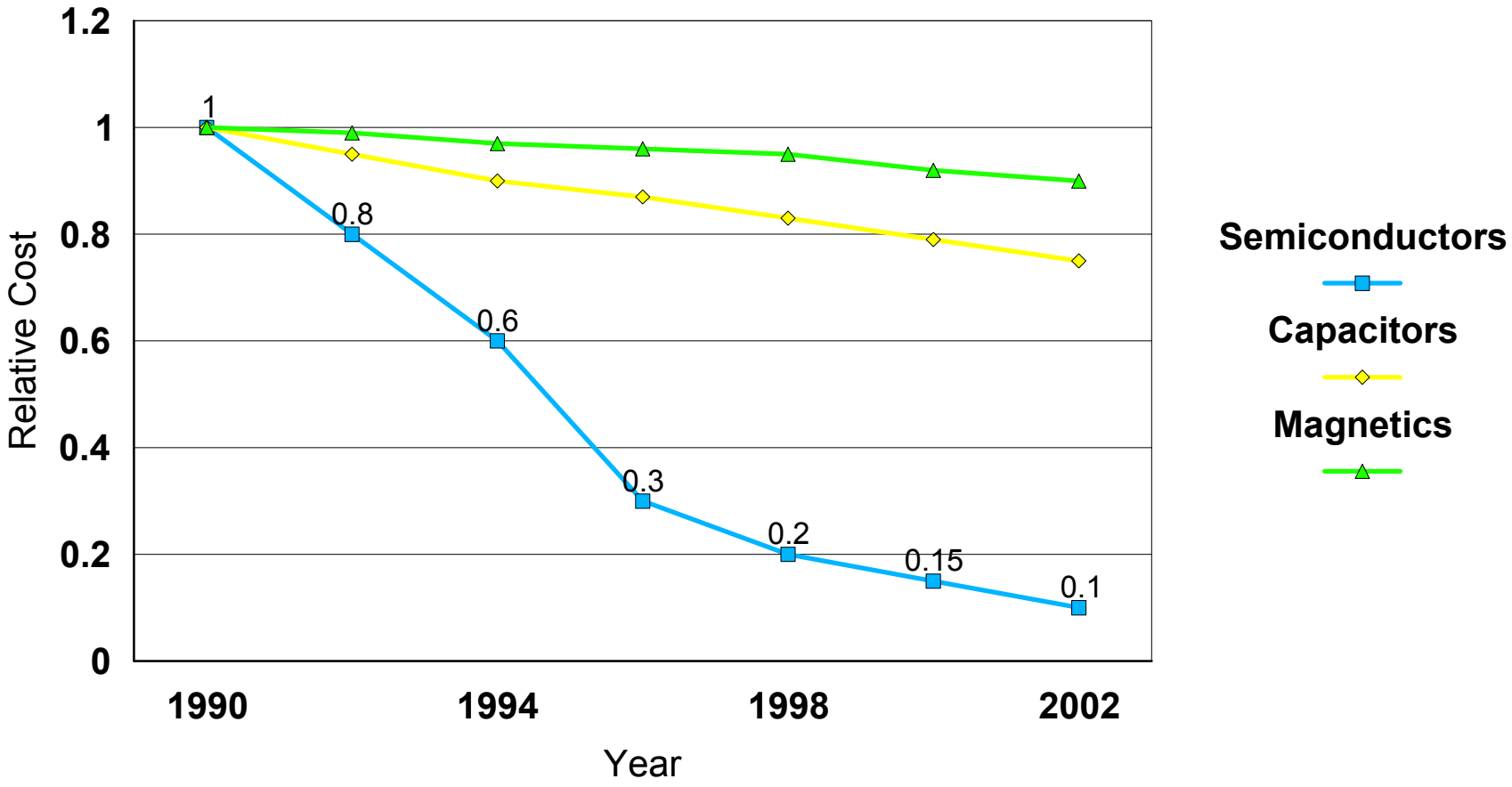
Typical Server Application



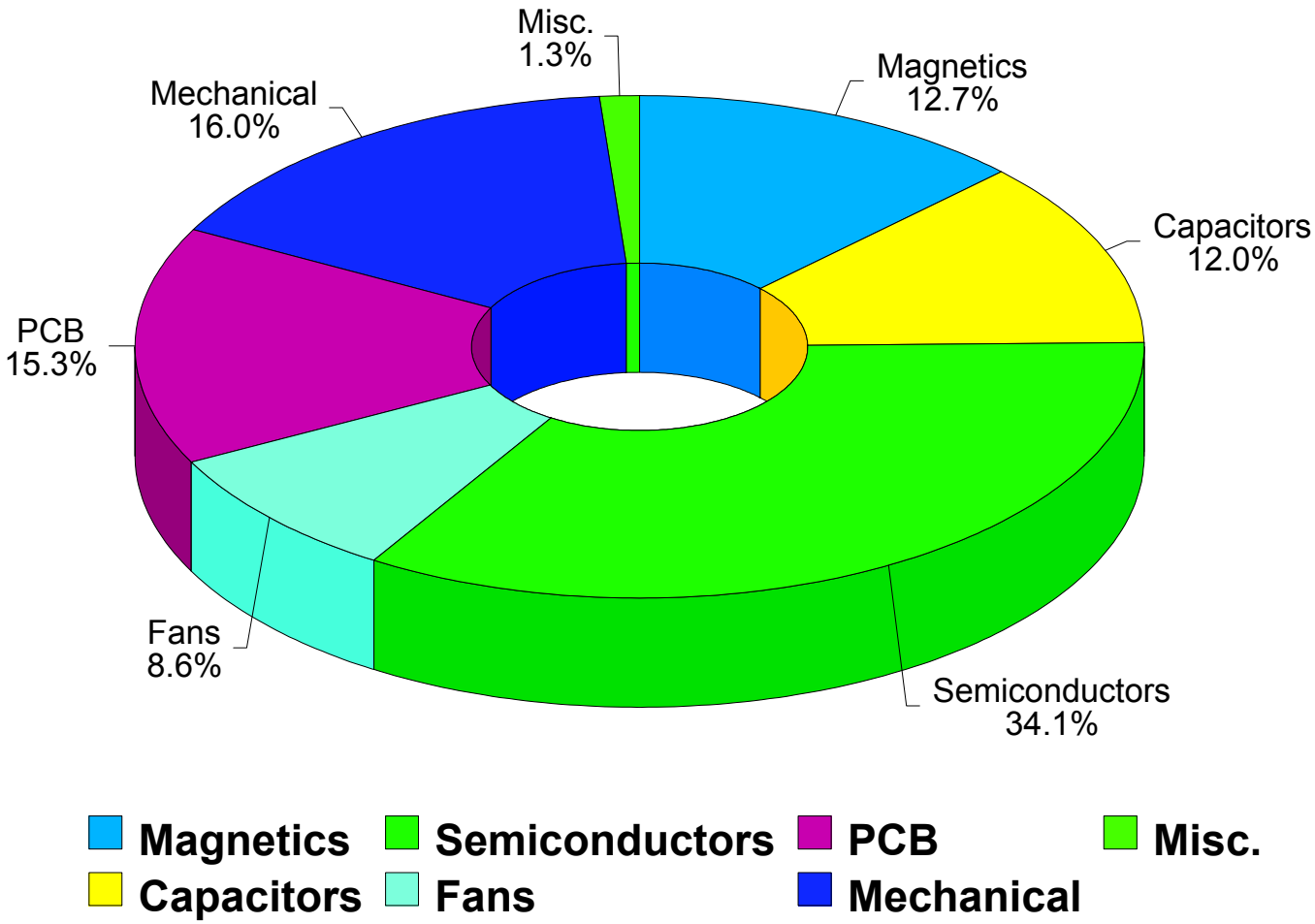
Power Supply Technology Drivers



Technology Cost Trend

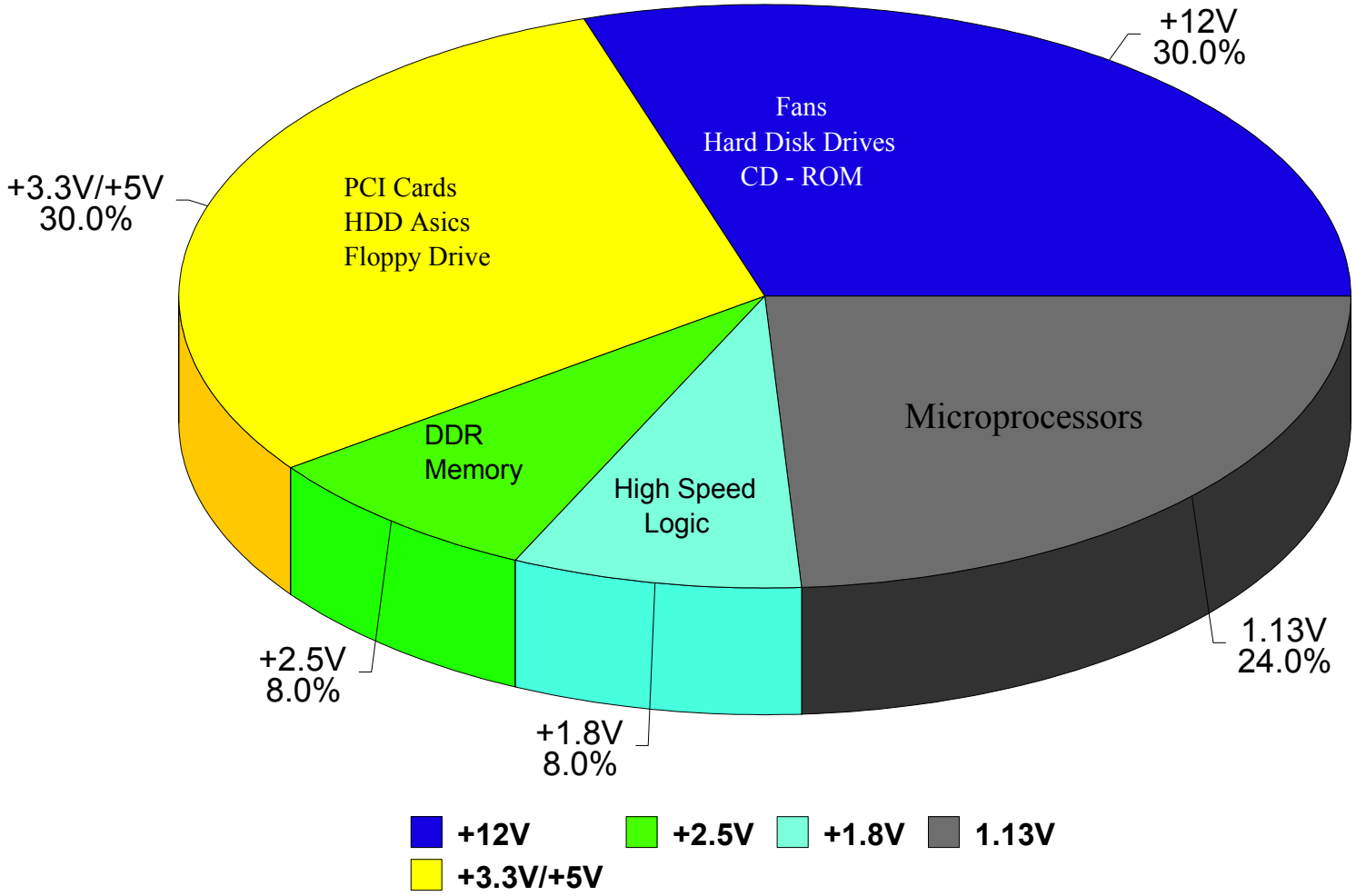


Bulk Power (AC/DC) Cost

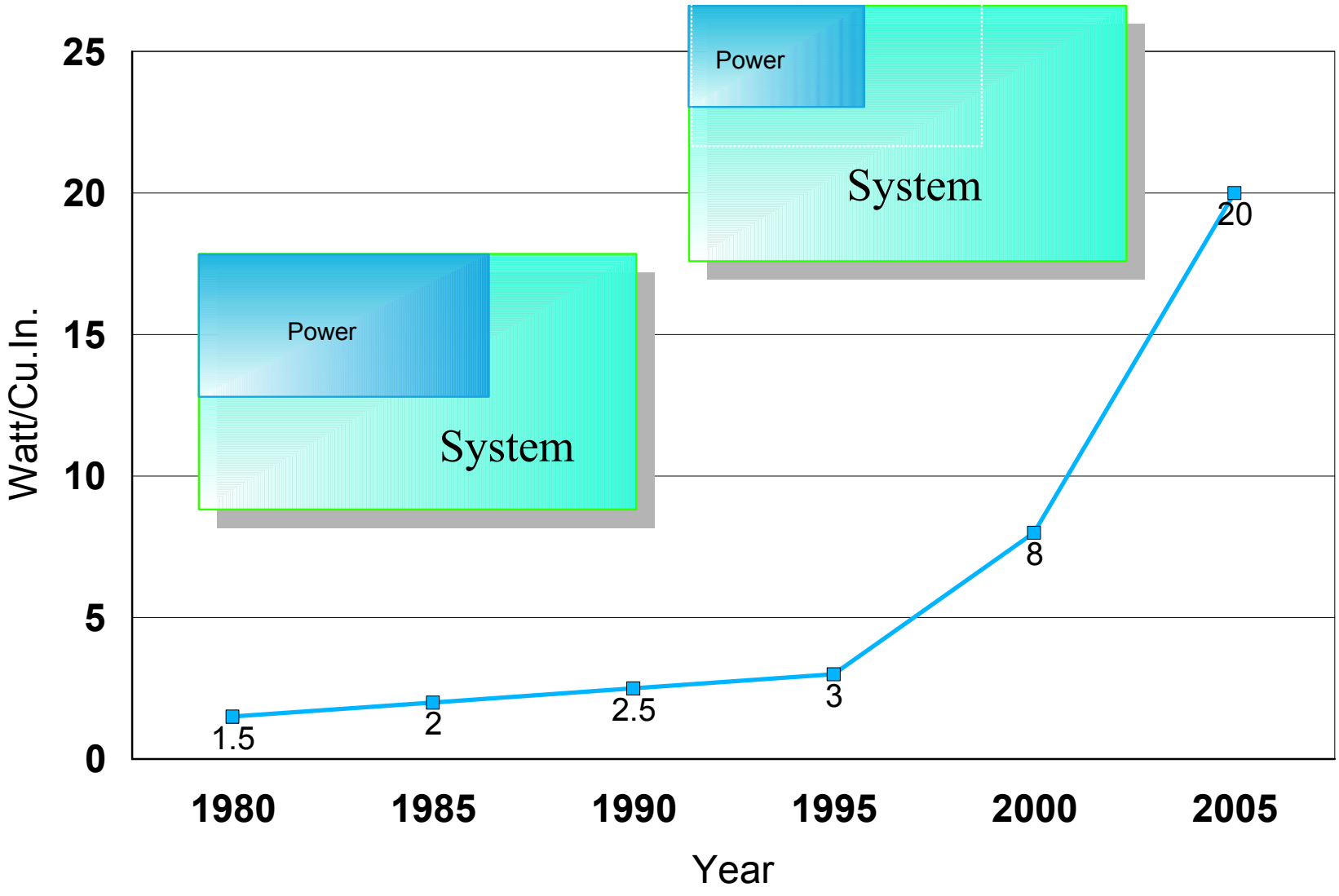


System Power Distribution

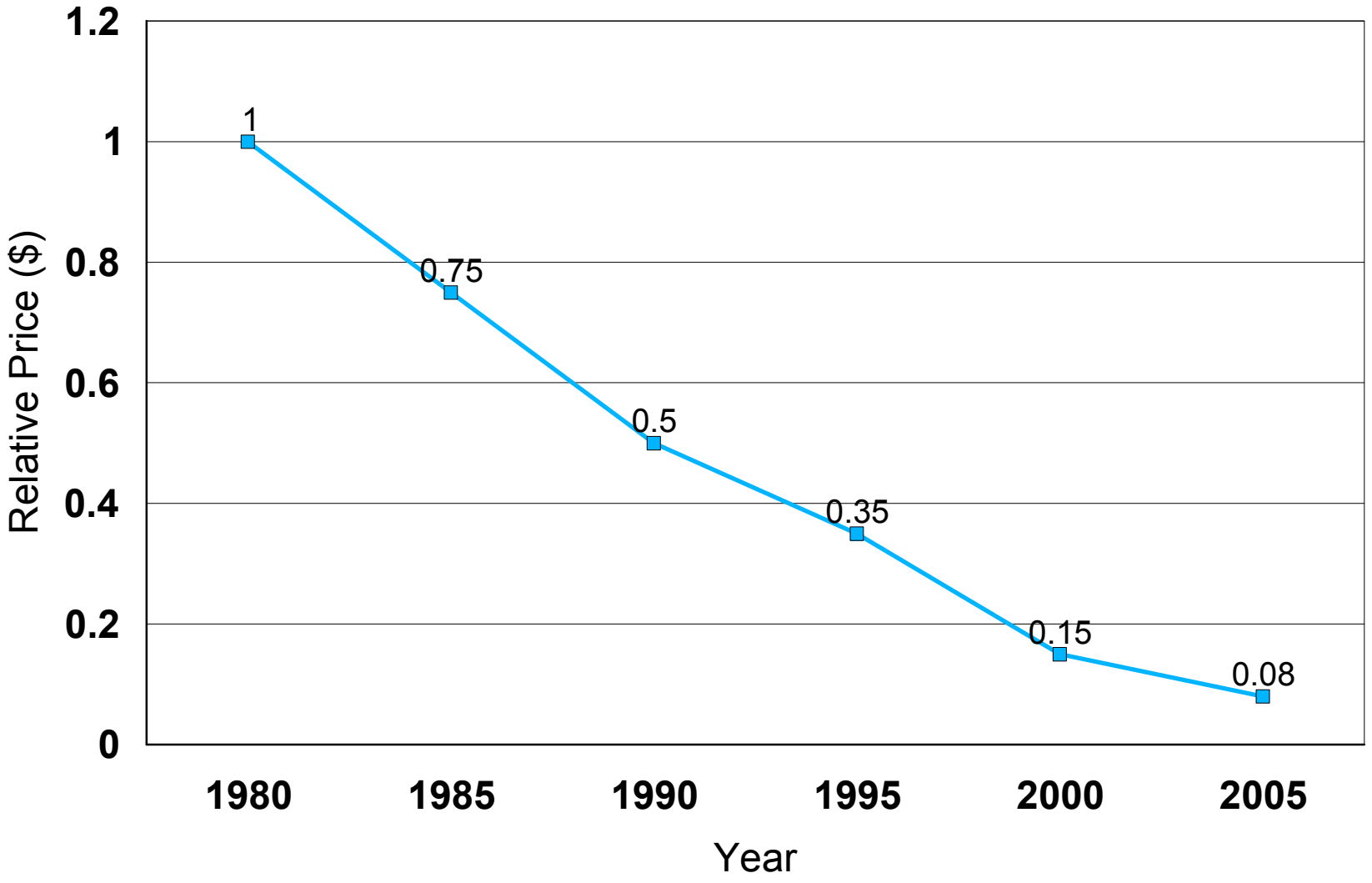
Why 12V?



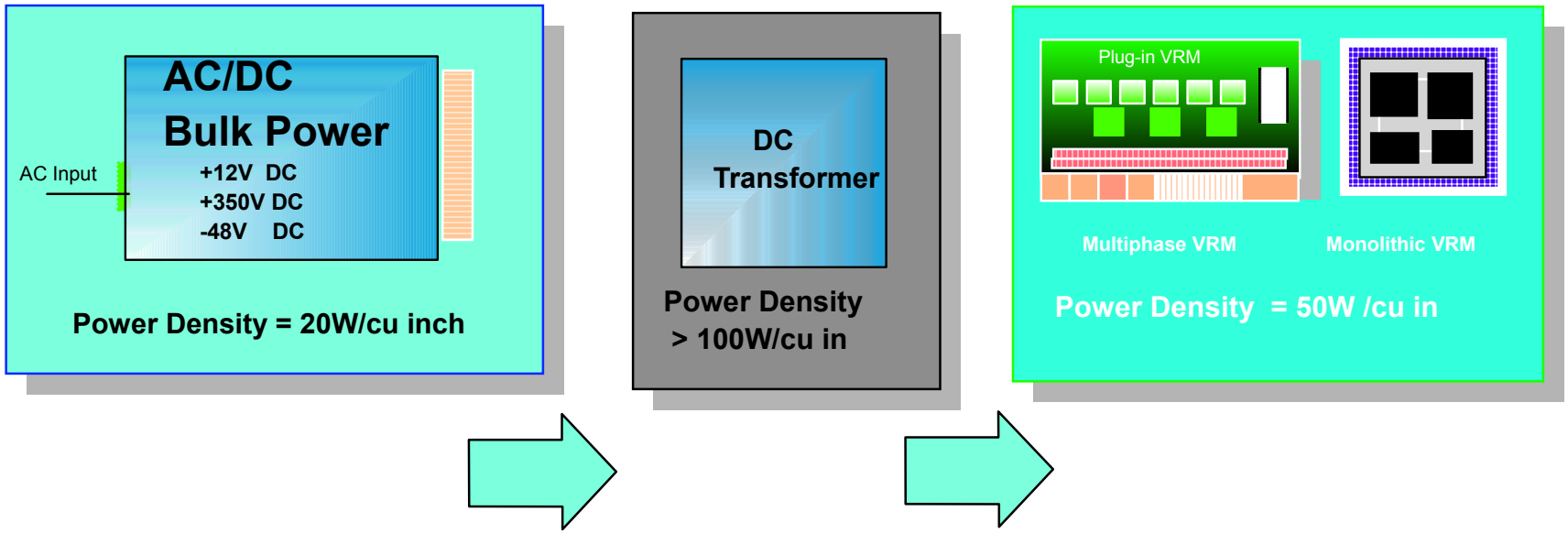
Power Density Trend



Price Trend


1.2
1
0.8
0.6
0.4
0.2
0
Relative Price ($)
1
0.75
0.5
0.35
0.15
0.08
1980
1985
1990
1995
2000
2005
Year

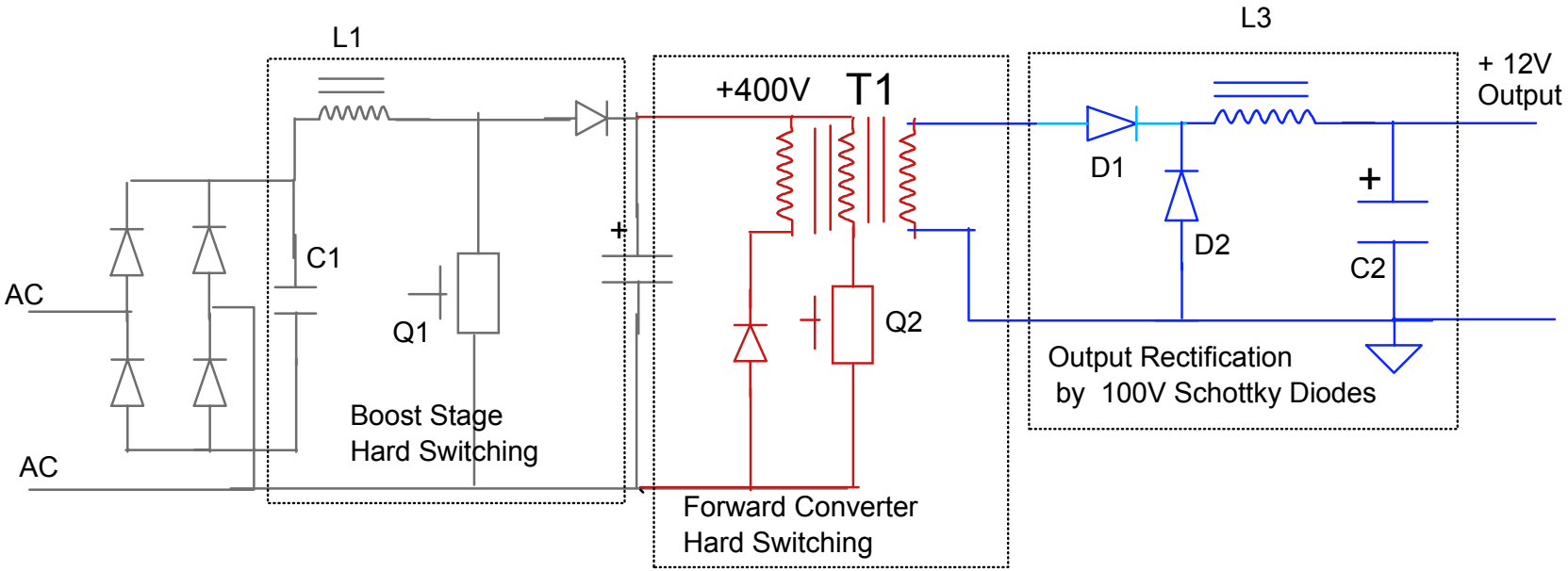
Power Electronics Technology Trend



Power Topologies

Technology Circuits

Note: The Conclusions are based on actual hardware experience.



Traditional Topology for Low End Server

No ZVS transition for Boost Stage = Larger Heatsinks required
Single Switch Forward = Large Size Transformer required
Simple Secondary Rectification = Large Size Inductor Required

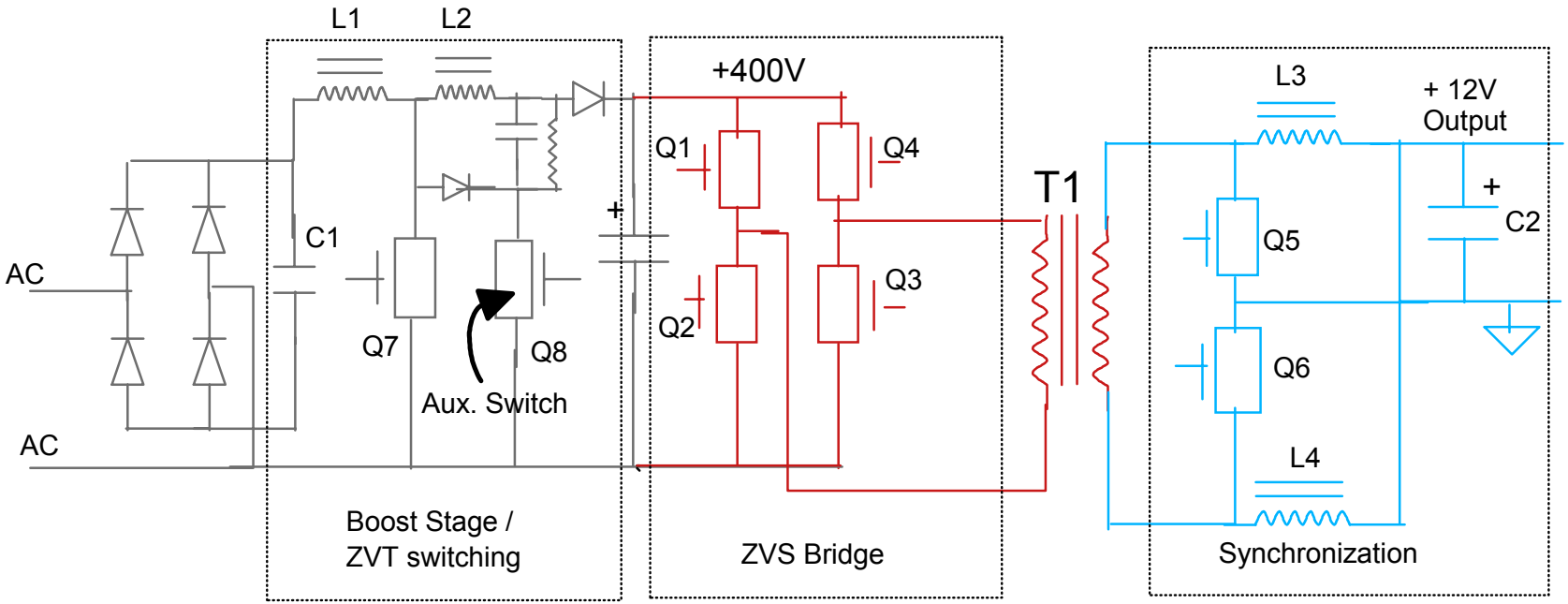
No Current Share Experience demonstrated by hardware Models

No MicroController Experience for Server Application

Lower Cost, Low Efficiency and Lower Power Density Approach

Power Topologies

Technology Circuits



Best of Breed Technology for Server Applications

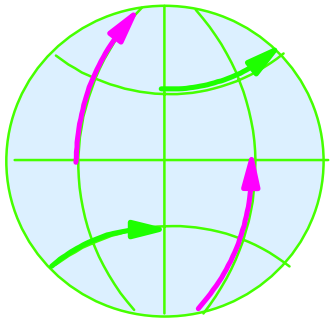
- ZVS transition for High Efficiency Boost
- ZVS Bridge Forward dor high efficiency DC/DC
- Synchronous rectification with Current Doubler
- MicroController Experience for Server Applications

High Efficiency, High Density and Better Cooling Methods.

Power Technology

Challenges

- Technology
- Cost



Power Technology

Technical Challenges and Solutions

Future Power Technical Challenges

- Higher Reliability - MTBF
- Higher Power Density
- Higher Transient Response - di/dt
- Higher Efficiency
- Lower Voltage - Higher Current
- Voltage/Current Distribution
- Increased Number Of Voltage Domains
- Ability to Hot Swap
- Error and Status Reporting
- Increased Mobile Client Power Needs
- Lower Cost
- Shorter Development Cycles
- Improved Quality

Technology Solutions

- More Integration
- Higher Switching Frequencies
- Lower Switching and Conduction Losses
- Topology Influences
  - RES/ZVS/ZCS
- Better EMI Design
- Innovative Design
- Lower Output Impedance
- Thermal Management
- Component Improvements
  - Integrated Circuits
  - Battery Technology
  - Power Semiconductors
  - Capacitors
  - Interconnect

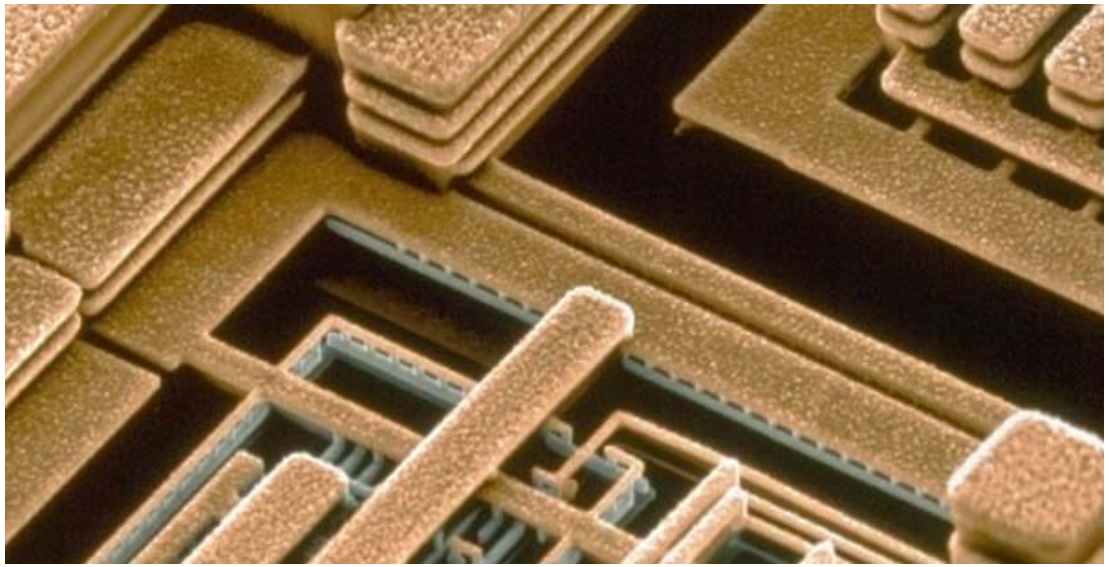
Power Architectures

CLASS	ARCHITECTURES
Mobile	■ Battery Technology Main Power Source ■ Efficient DC/DC Converters & Power Management
Low End	■ Centralized Power Supply ■ Point-Of-Load Regulator (uP or Memory)
Mid-Range	■ Centralized Power Supply * Point-Of-Load Regulator (uP or Memory) * DC/DC Regulators Imbedded in PS ■ Fully Distributed Power Supply * +12V Bus Voltage * +12V Input DC/DC ■ Telco (-48V) Version
High End	■ Fully Distributed Power Supply * +350V Bus Voltage * +350V Input DC/DC ■ Fully Distributed Power Supply * +48V Bus Voltage * +48V Input DC/DC

Technology Challenges

- **Faster Semiconductors Require:**

Higher Current
Lower Voltage

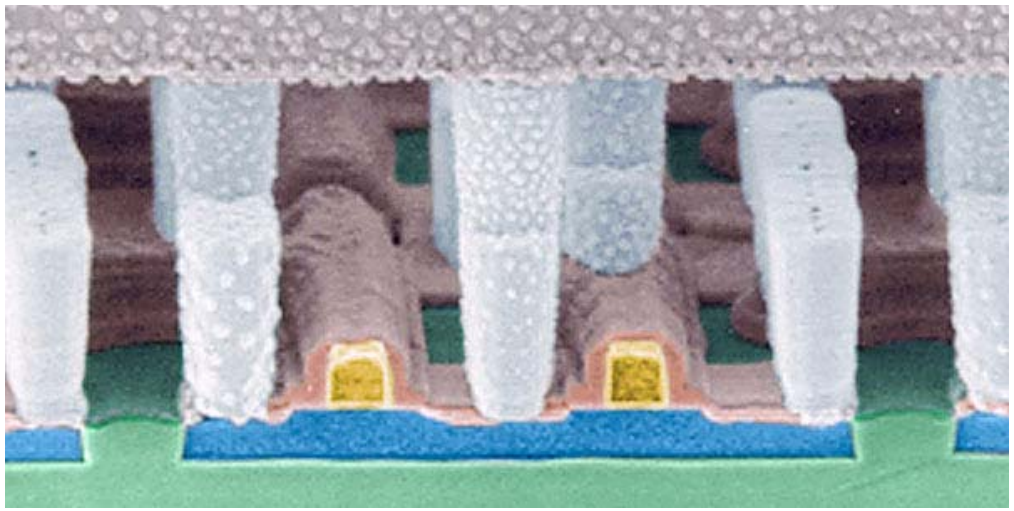


IBM CMOS7S Copper Technology

Technology Challenges

- **Faster Semiconductors Cause:**

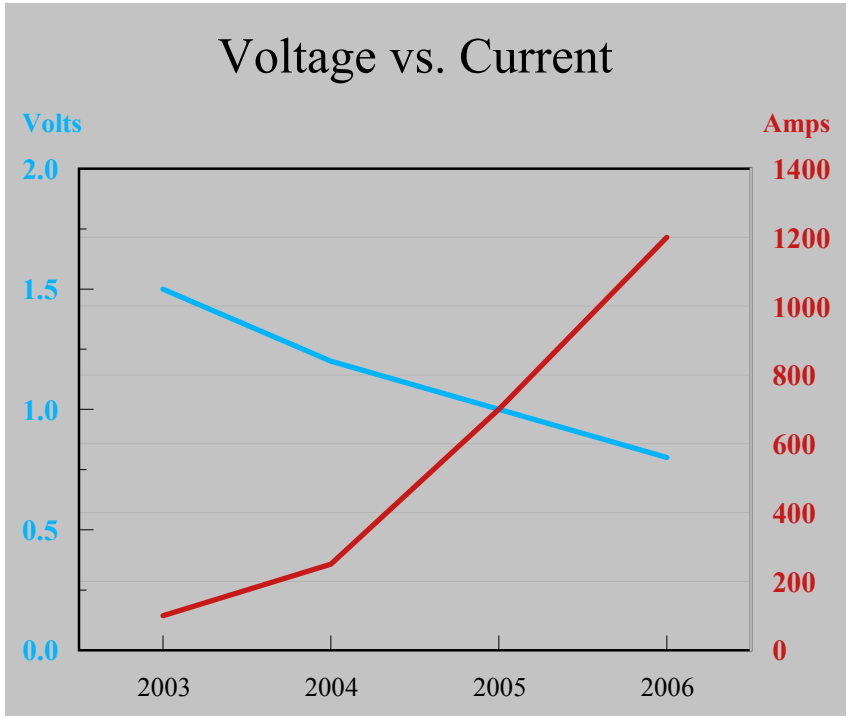
High di/dt



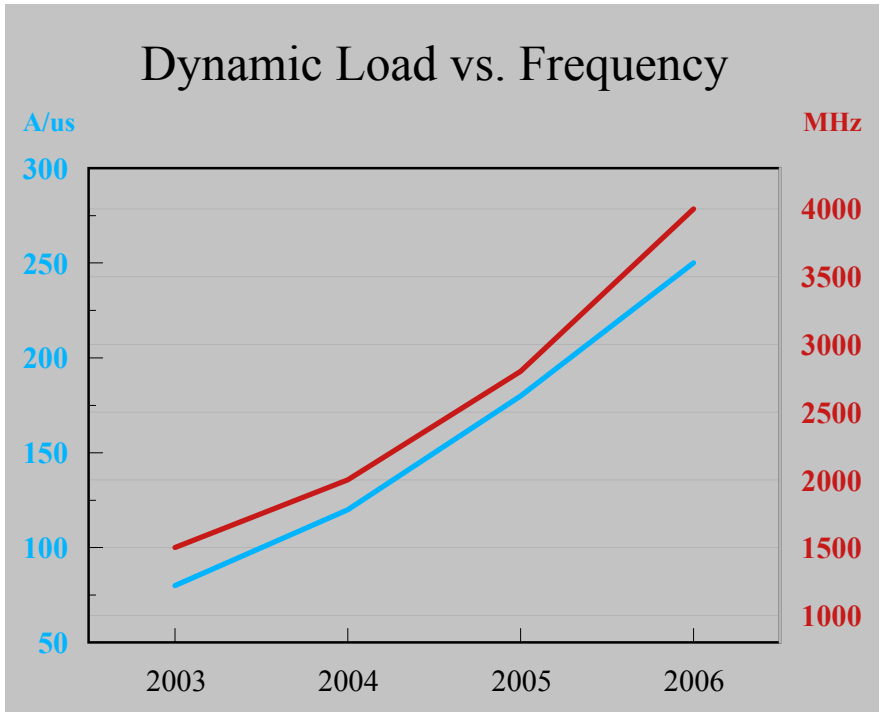
IBM SOI Technology

Technology Challenges

Processor Power Trends



Power per Cell Decreasing
Function Increasing
N-Way Processors



Larger Chips/More Integration
Multi-Chip Modules
Higher Operating Frequencies

Power Technology

Technology Challenges → di/dt, efficiency

- High di/dt Requires A Fast Response Converter
- di/dt Requirements are up to 250 Amps/uS with Year 2006 Requirements Expected To Reach 1000 Amps/nS (a 4000x increase!!)
- Adding Low ESR, Expensive Capacitors Is No Longer Feasible For Future Low And Midrange Systems
- System Thermal Requirements Call For High Efficiency Converters

Skills Expected of Our Suppliers

What Technical Capabilities Are Expected From Our Suppliers?

- Simulation/Modeling Capabilities
  - Electrical
  - Thermal
  - Mechanical
- Innovative Designs
  - DC/DC For Next Generation Processors
  - High Density AC/DC
  - Improved Efficiency
- Common Industry Design Techniques
  - Form Factor
  - Connector
  - Communication
  - Current Sharing

Entry Level Engineer Expectations

	Proficiency
✓ Switching power supply technology	4
✓ Analog circuit design and analysis techniques	3
✓ Understanding of magnetics	3
✓ Simulation skills	3
• Basic understanding	
✓ Communication skills	5
• Written	
• Oral	
✓ Teamwork experience and skills	5

Experienced Engineer Expectations

	Proficiency
✓ Power supply design experience	5
✓ Analog circuit design and analysis	5
✓ Magnetic component design and implementation	5
✓ Analog simulation	5
✓ Digital design	4
✓ Digital simulation	3
✓ Verbal communication	5
✓ Written communication	5
✓ Teamwork experience and skills	5