Small Computer System Interface - Part 1

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Outline

1. *SCSI Basics (geeks.com, tech-tips)*
   - ✓ *The Basics*
   - ✓ *Performance*
   - ✓ *Price*
   - ✓ *Reliability*

2. *More than an interface – SCSI vs. ATA (March 2003)*
   - ✓ *Introduction*
   - ✓ *Technology Differences*
   - ✓ *Performance Differences*
   - ✓ *Conclusions*

SCSI Basics

COMPUTER GEEKS (geeks.com), tech-tips HARDWARE

SCSI Basics

The Basics

- ✓ Small Computer System Interface(SCSI), ATA ➔ first introduced in 1986
- ✓ "skuzzy"
- ✓ "host adaptor"(adaptor card), connecting SCSI drives to the motherboard

SCSI Basics

- **The Basics – On board vs. Adaptor card**

On board SATA Connector

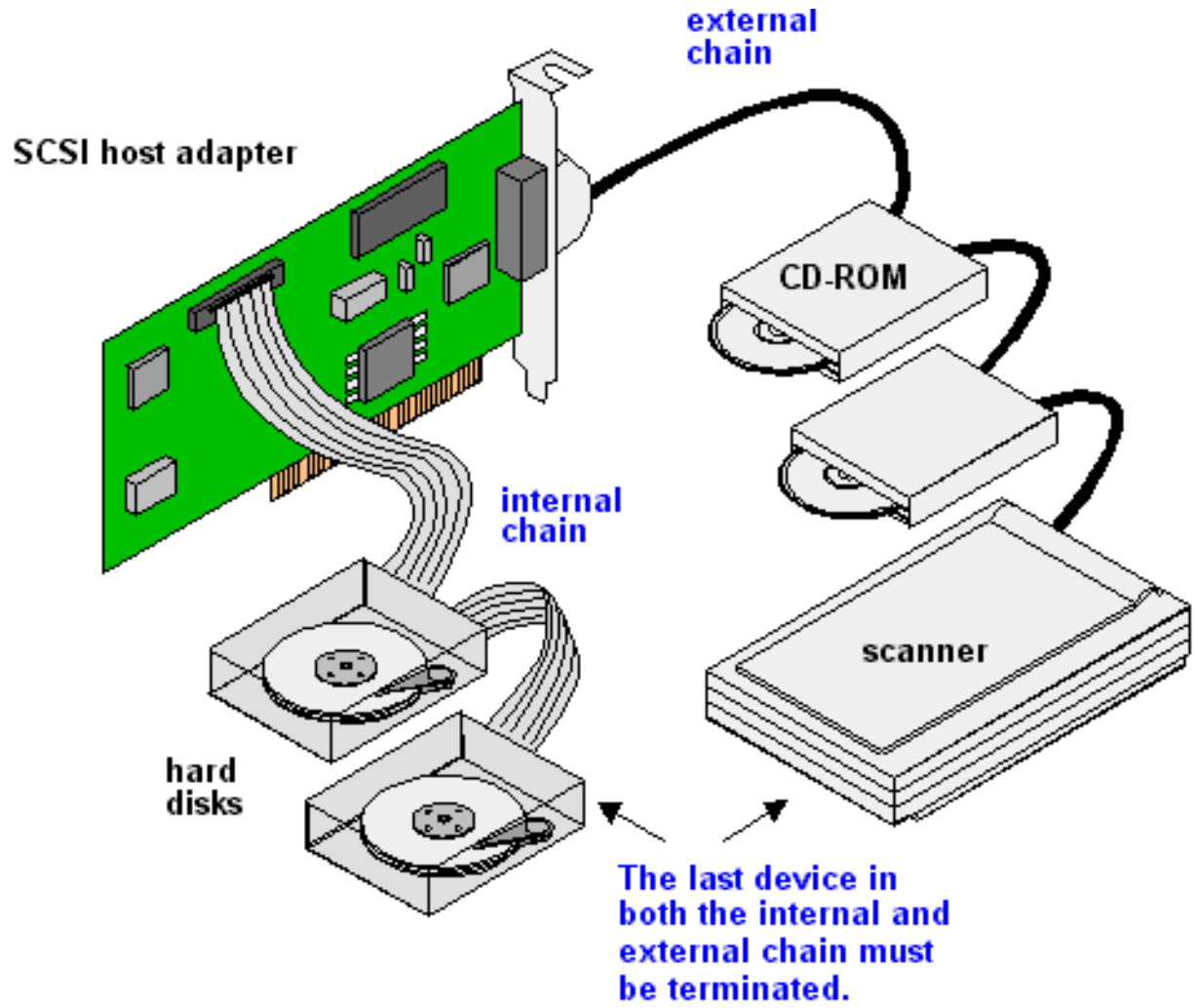
SCSI Adaptor card

- ✓ On board 40-pin ATA connector & 7-pin SATA connector
- ✓ PCI or PCI-X slots, SCSI 25, 50, 68, 80-pin
- ✓ SCSI drives can communicate directly, requiring almost no CPU support

SCSI Basics

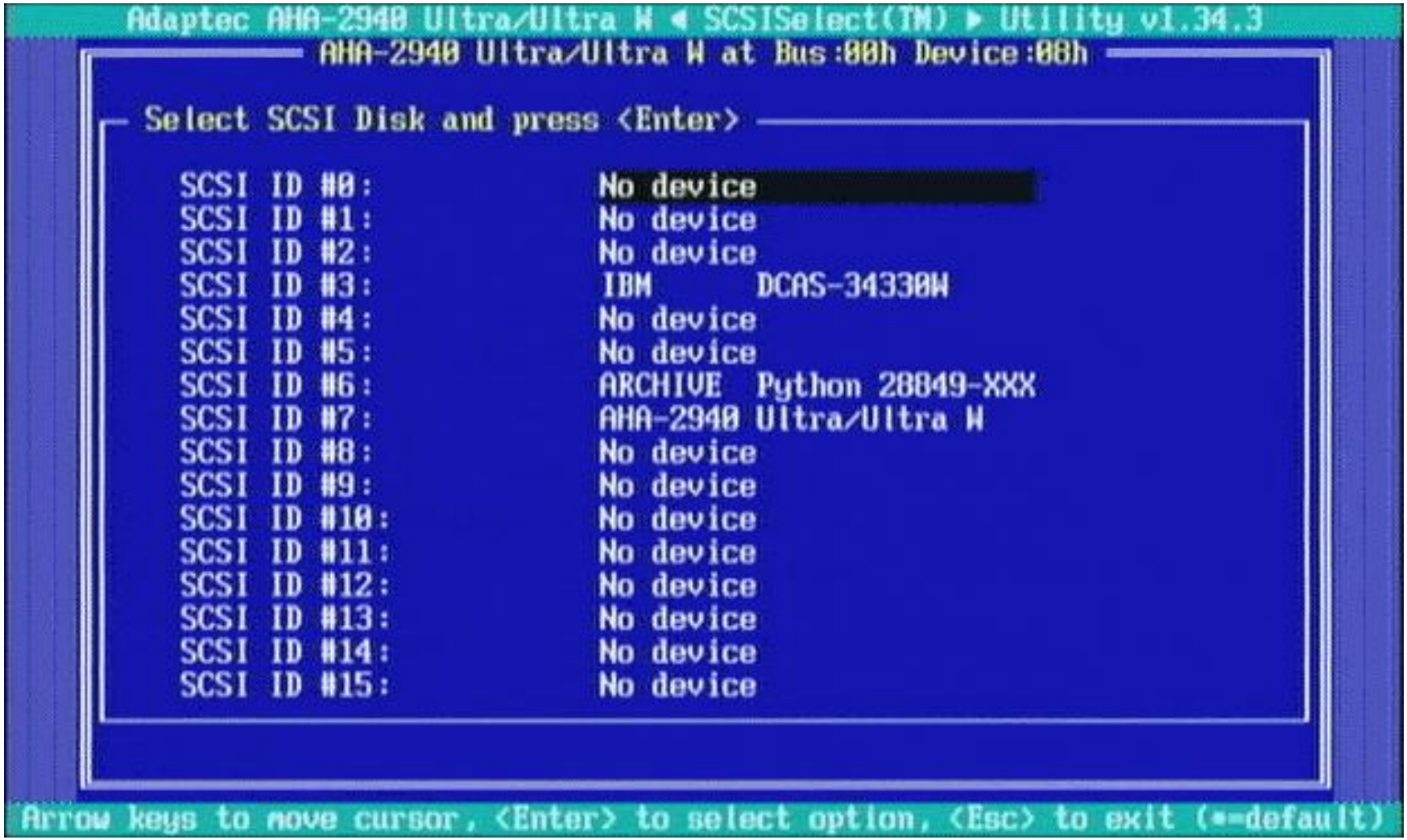
- **The Basics – The cables**

  - ✓ ATA - Max 2 devices
  - ✓ SATA - Max 1 device
  - ✓ SCSI
    - daisy chain
    - Max 16 devices



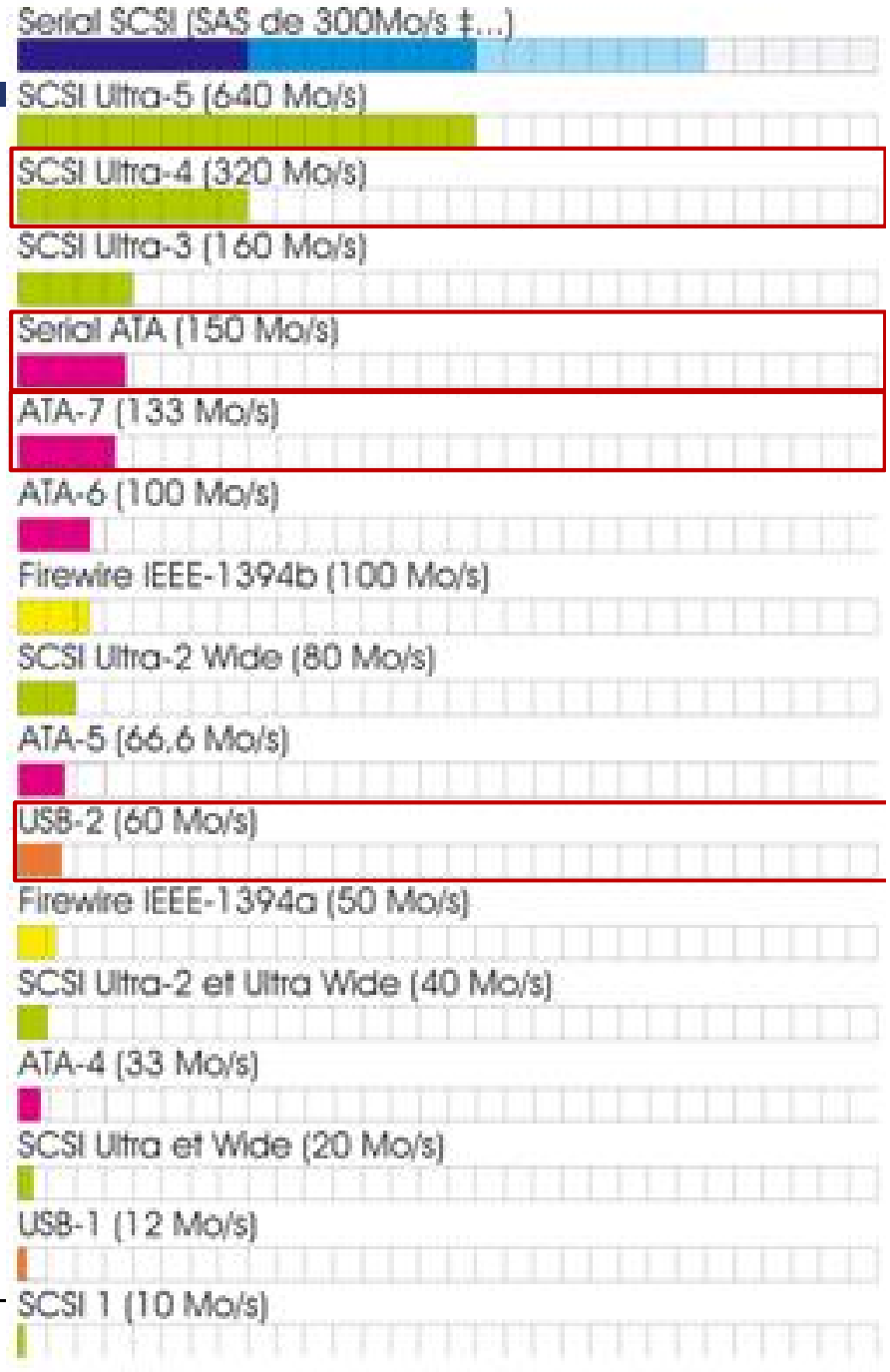
SCSI Basics

- **The Basics – The cables**



SCSI Basics

- **The Basics – Performance**
  - ✓ SCSI 1 – 5 MBps | 8 bit wide (5 MHz)
    - 8 devices per 1 controller channel
  - ✓ Ultra320 SCSI – 320 MBps | 16 bit wide (40 MHz)
    - 16 devices per 1 controller channel



SCSI Basics

The Basics – Performance SCSI vs. ATA

	Transfer speed (MB/s)	Max. cable length (m)	maximum connecting devices
SCSI 1	5	-	8
Ultra 320 SCSI	320	12	15 (plus the HBA; Host Bus Adaptor)
PATA-133	133	0.46	2
SATA-150 (SATA I)	150	1	1
SATA-300 (SATA II)	300	1	1

SCSI Basics

The Basics – Prices

	Disk size (GB)	RPMs	Prices (WON)
Ultra 320 SCSI	146	15,000	326,100
	300	10,000	630,000
SAS	300	15,000	514,000
EIDE(ATA-133)	320	7,200	74,000
SATA2(SATA-300)	320	7,200	54,700

SCSI Basics

The Basics – Reliability

- ✓ One of the key reason for SCSI's higher price is reliability
- ✓ SCSI drives are built to a much higher standard than typical ATA or SATA drives
- ✓ Mean Time Between Failure(MTBF)
  - 1.5 million hour on SCSI
  - 1 million hour on SATA or less
- ✓ Operation Uptime
  - SCSI - 24/7
  - ATA or SATA - 8 hours per day

More than an interface – SCSI vs. ATA

2nd Annual Conference on File and Storage Technology (FAST), 2003

Introduction

Categorize

✓ Personal Storage

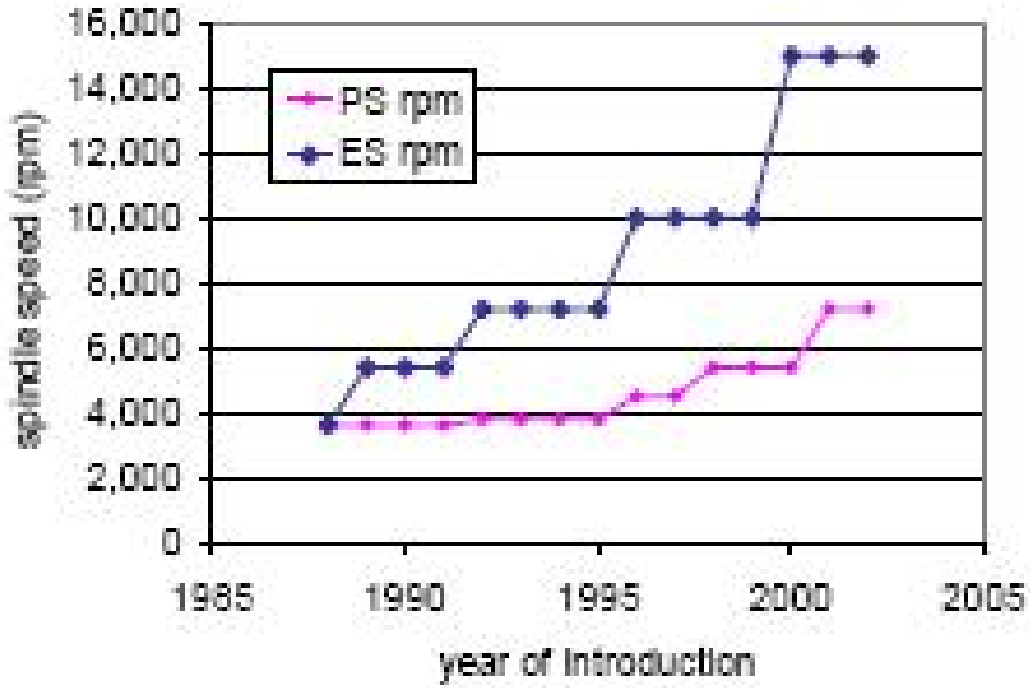
- personal computer market uses to the first low-cost hard discs

✓ Enterprise Storage

- To be configured in groups (aggregation)
- To randomly access small portions of large data spaces
- reliability and performance are critical characteristics

Introduction

- RPM

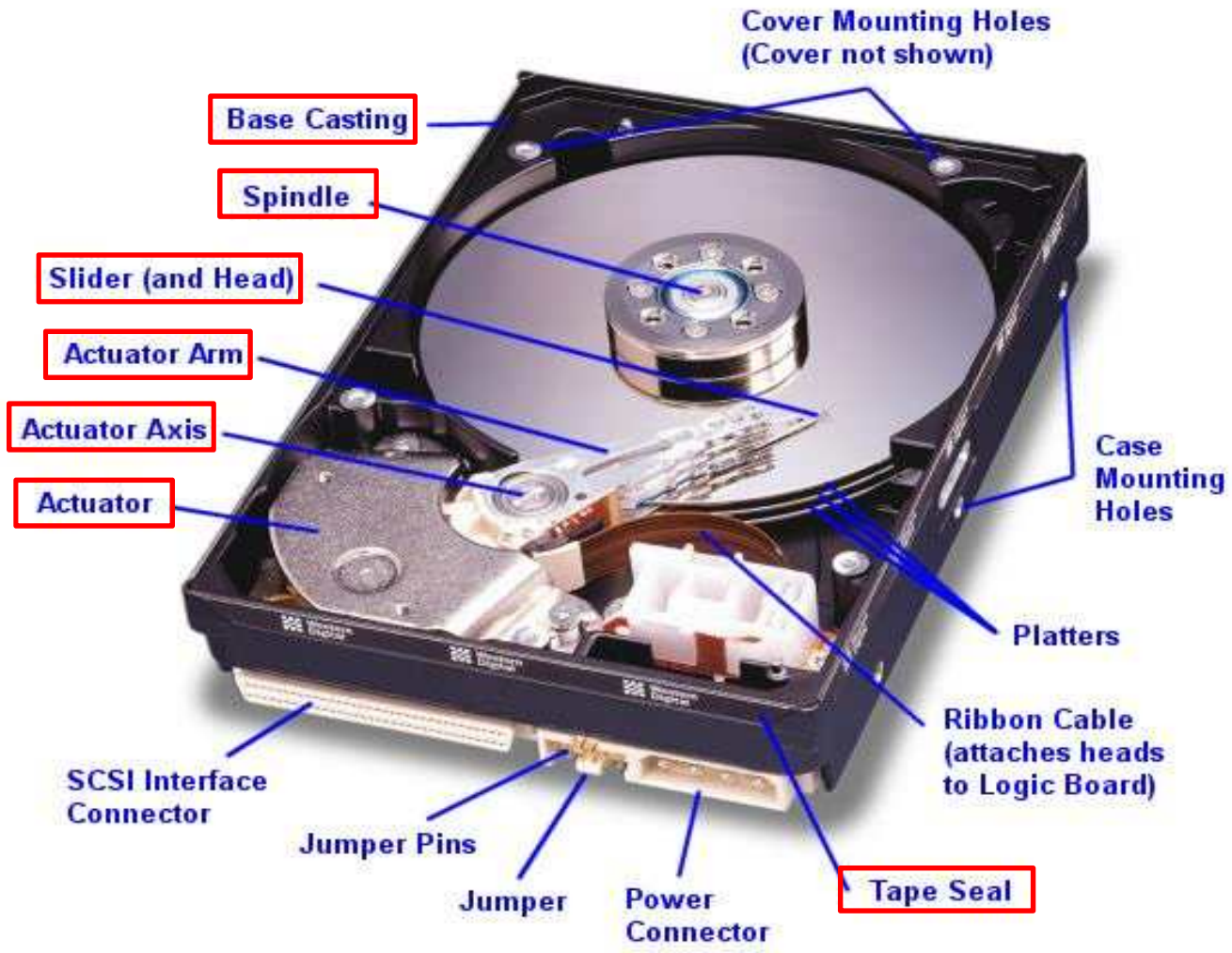


Technology Differences

- Mechanics - major components

Technology Differences

- Mechanics – Head/Disc Assembly



Technology Differences

Mechanics – Head/Disc Assembly (ES)

- ✓ Head/Disk Assembly(HDA) – heads, actuator, spindle, discs, air handling system
- ✓ ES drives operates at higher rpm
  - maintaining a higher tolerance for external disturbance
  - require more power to operate, creating more heat
  - In the event, can be the influence of neighboring drives
- ✓ To prevent :
  - filter for particles, desiccant to control humidity, eliminating organic
  - O-ring seals, better gasketing, air control system
- ✓ These little things adds cost but improves reliability

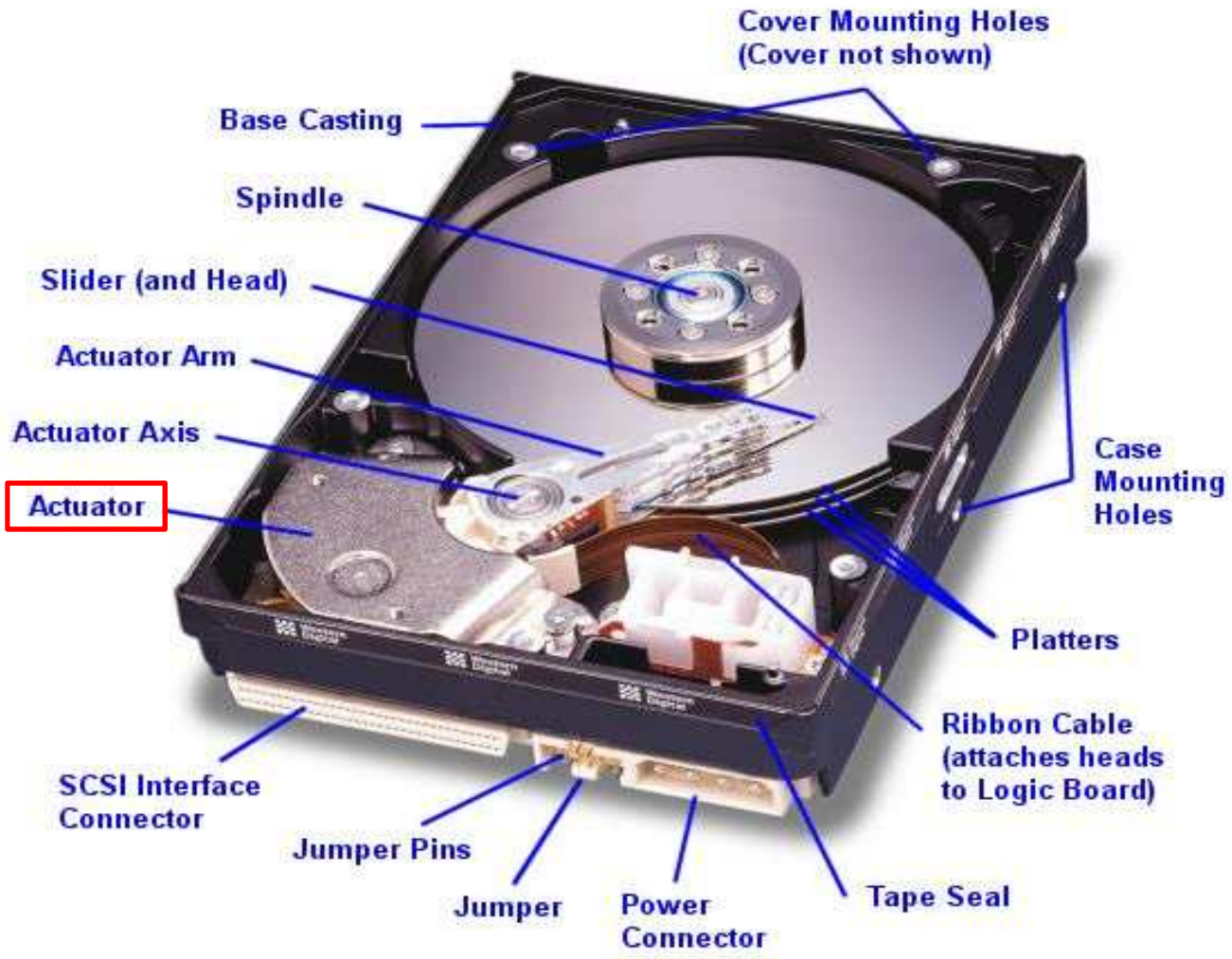
Technology Differences

Mechanics – Head/Disc Assembly (PS)

- ✓ PS drives are designed for reliability
- ✓ But they tend to compromise where components can be eliminated to save cost
- ✓ The O-rings and desiccant, for example, are usually eliminated in PS drives

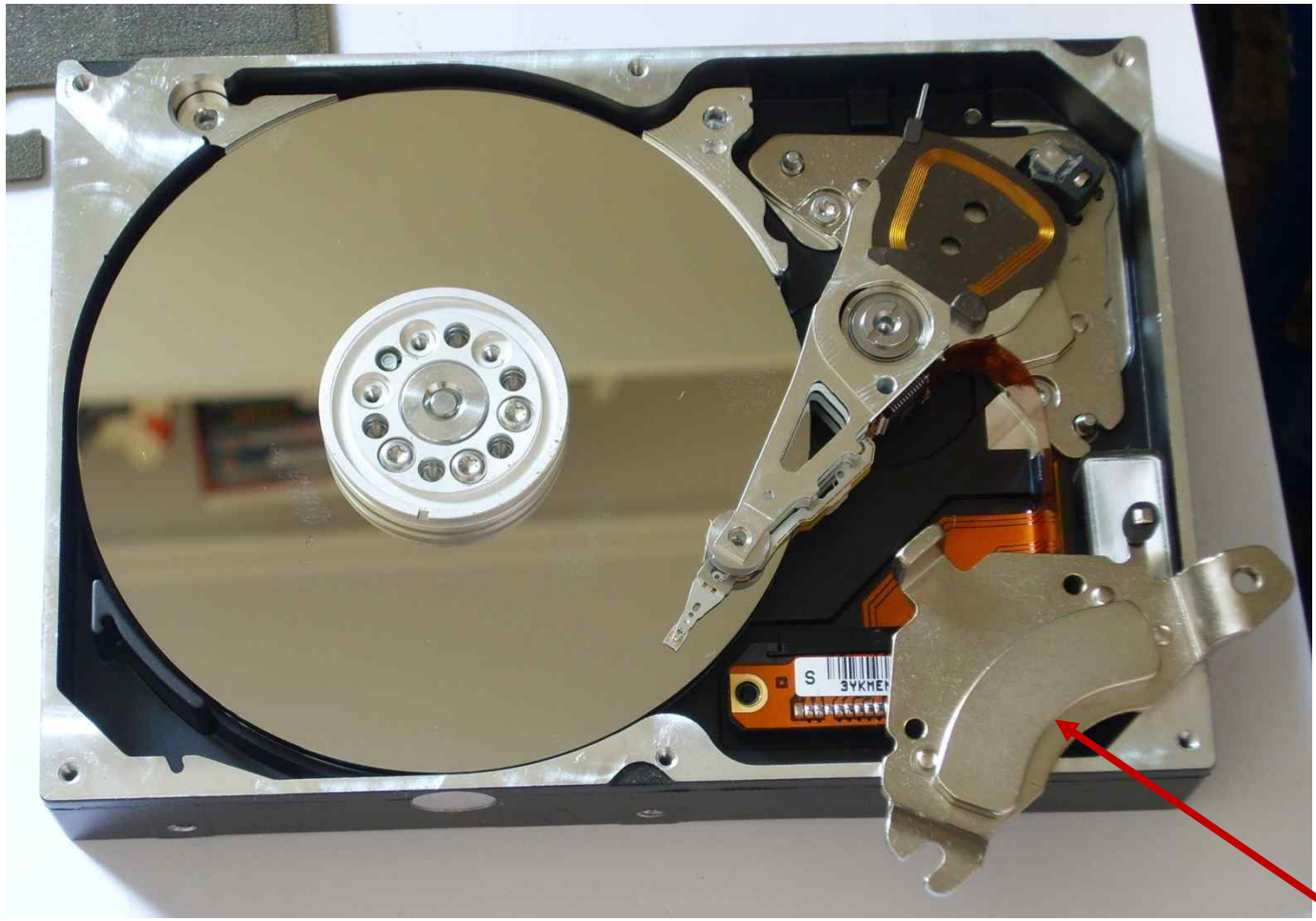
Technology Differences

Mechanics – Actuator



Technology Differences

Mechanics – Actuator



Magnet Actuator

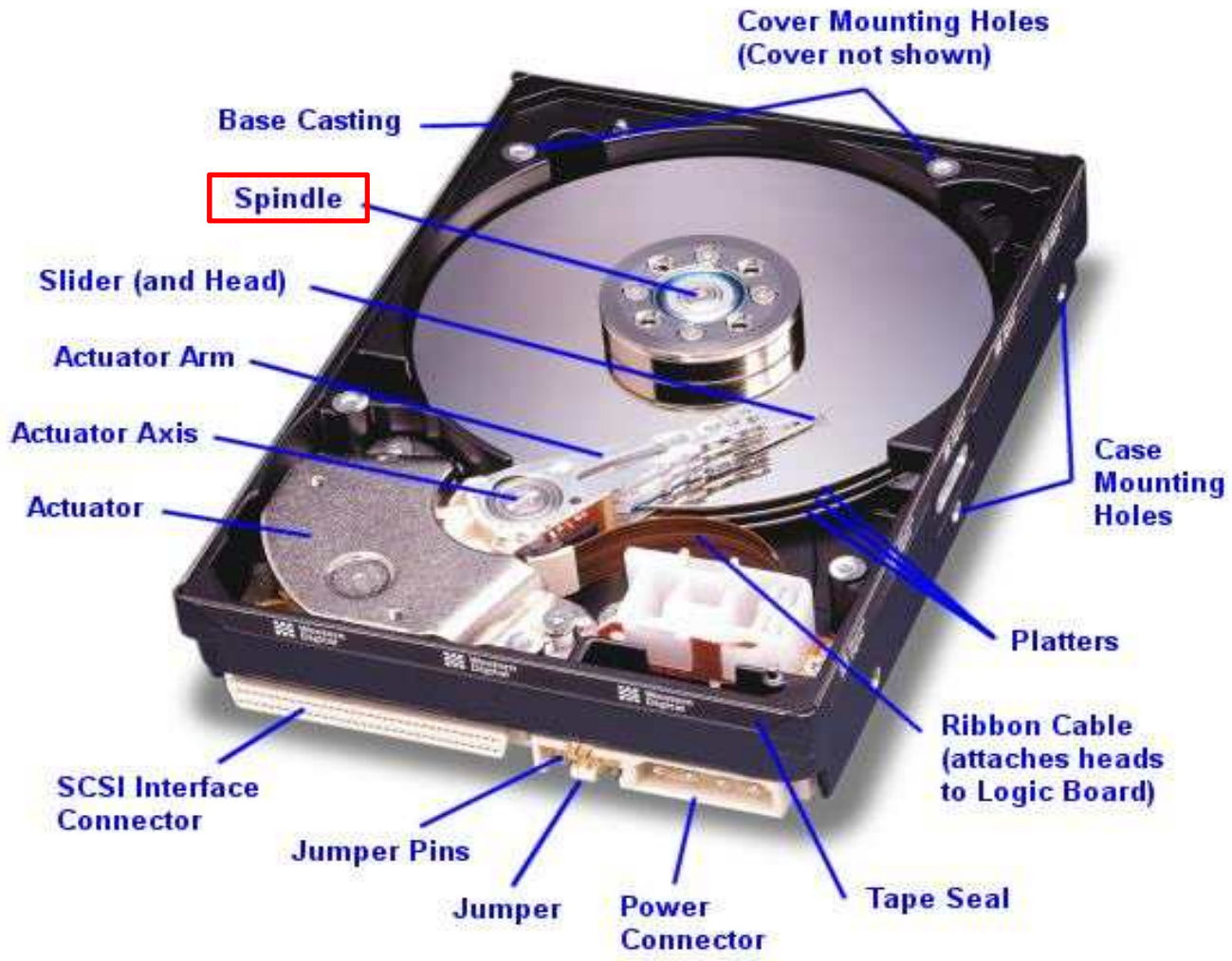
Technology Differences

Mechanics – Actuator

- ✓ Larger magnets are key to achieving faster seek times ➔ higher cost
- ✓ Inside every drive is a latch to hold the actuator when power is off
- ✓ The latch has a magnetic field associated with it, affect seek performance when the actuator is operating near the latch
- ✓ In PS drive, no compensation for this, as seek performance is not critical
- ✓ ES drives have a bi-stable latch that does not affect performance

Technology Differences

Mechanics – Spindle



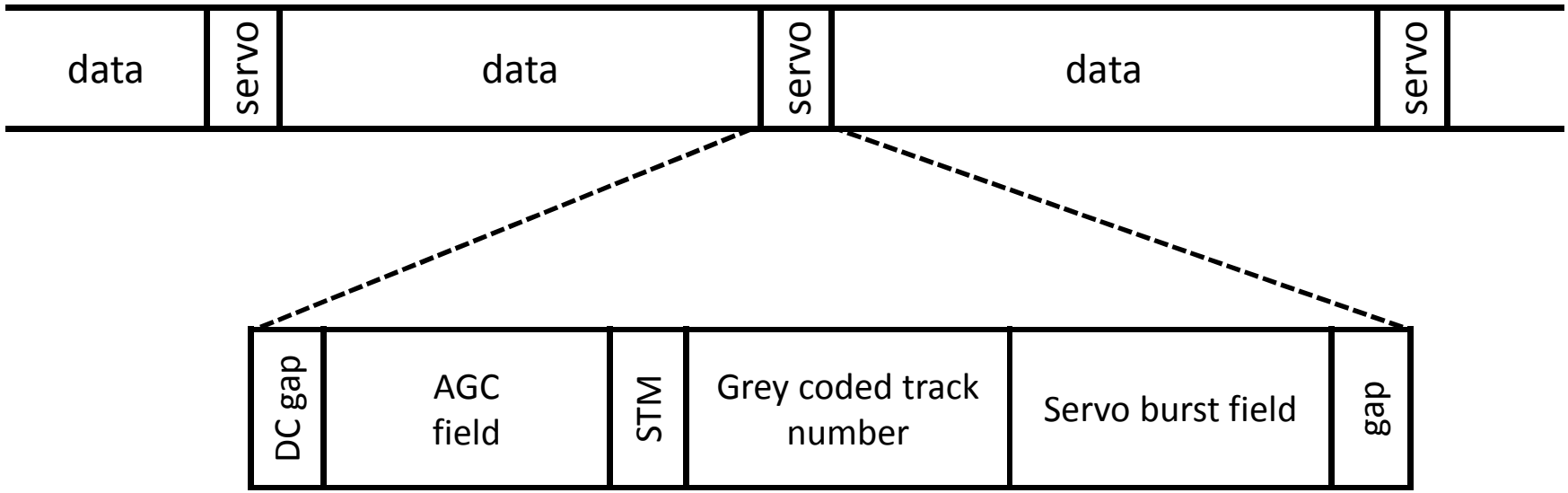
Technology Differences

Mechanics – Spindle

- ✓ For over 15 years drives spun no faster than 3,600 rpm
- ✓ 3,600 rpm ➔ 5,400 rpm ➔ 7,200 rpm ➔ 10,000 rpm ➔ 15,000 rpm
- ✓ Higher rpm ➔ Off-track head ➔ *mis-read* and a *rotational miss*
- ✓ Higher rpm requires more expensive motors, windage, and vibration
- ✓ PS drives use a cantilever motor design, only at the base deck end
- ✓ ES motor at both ends, with an attachment to the top cover ➔ cost extra

Technology Differences

- **Electronics – Servo processor**



Technology Differences

Electronics – Interface

- ✓ ES drive characteristic
  - the ES ASIC gate count is more than 2x a PS drive
  - the embedded SRAM space for program code is 2x
  - the permanent flash memory for program code is 2x
  - data SRAM and cache SRAM space is more than 10x
- ✓ ES drive - two processors
  - one dedicated to servo
  - other for interface and read/write handling
- ✓ PS drive – single processor
  - handle all three basic processor tasks (interface, read/write, servo processing)

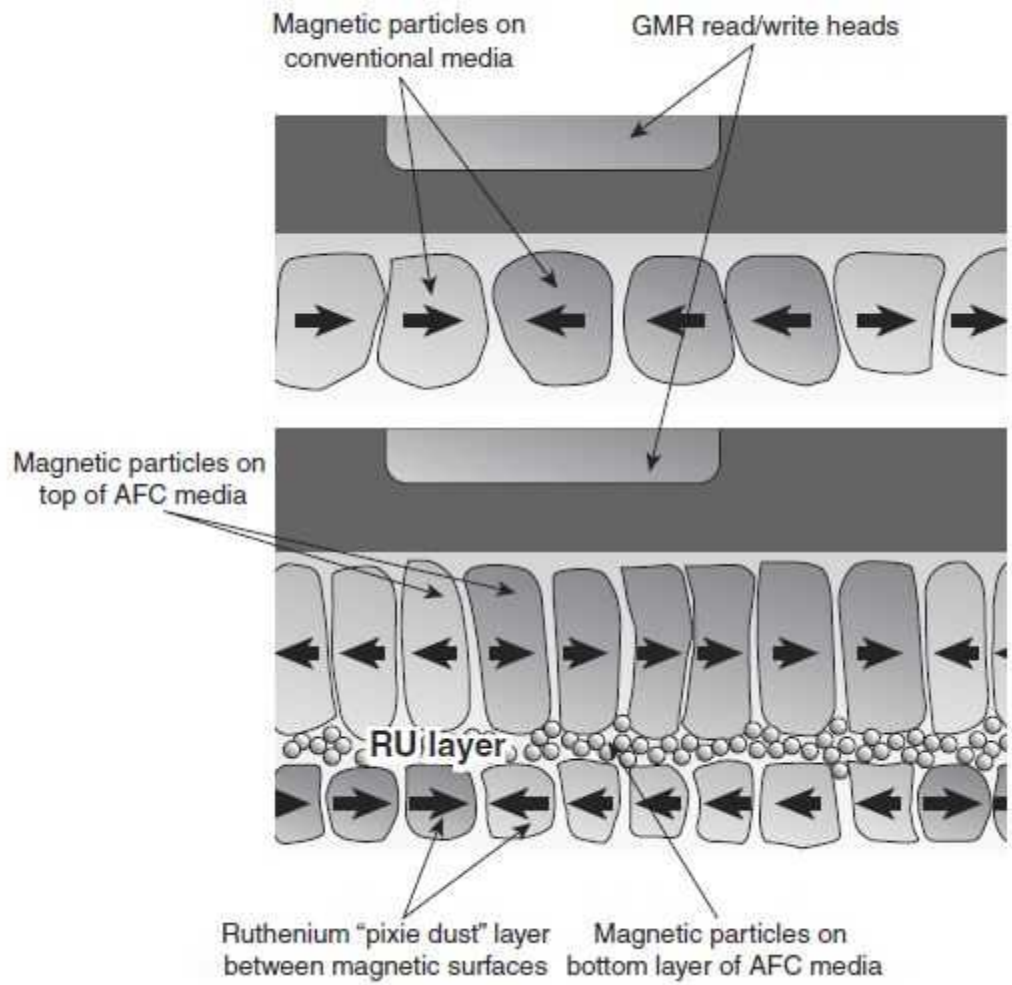
Technology Differences

Electronics – Memory

- ✓ ES command set is more than twice as large as that for ATA
- ✓ requiring more permanent flash for code and increased SRAM at runtime
- ✓ allows for vendor-specific extensions which require additional code space
- ✓ allowing greater flexibility in configuration

Technology Differences

Electronics – Materials



Technology Differences

Electronics – Manufacturing

- ✓ The build and test times for ES drives are considerably longer than PS drives
- ✓ Increased test time ➔ more reliable

Performance Differences

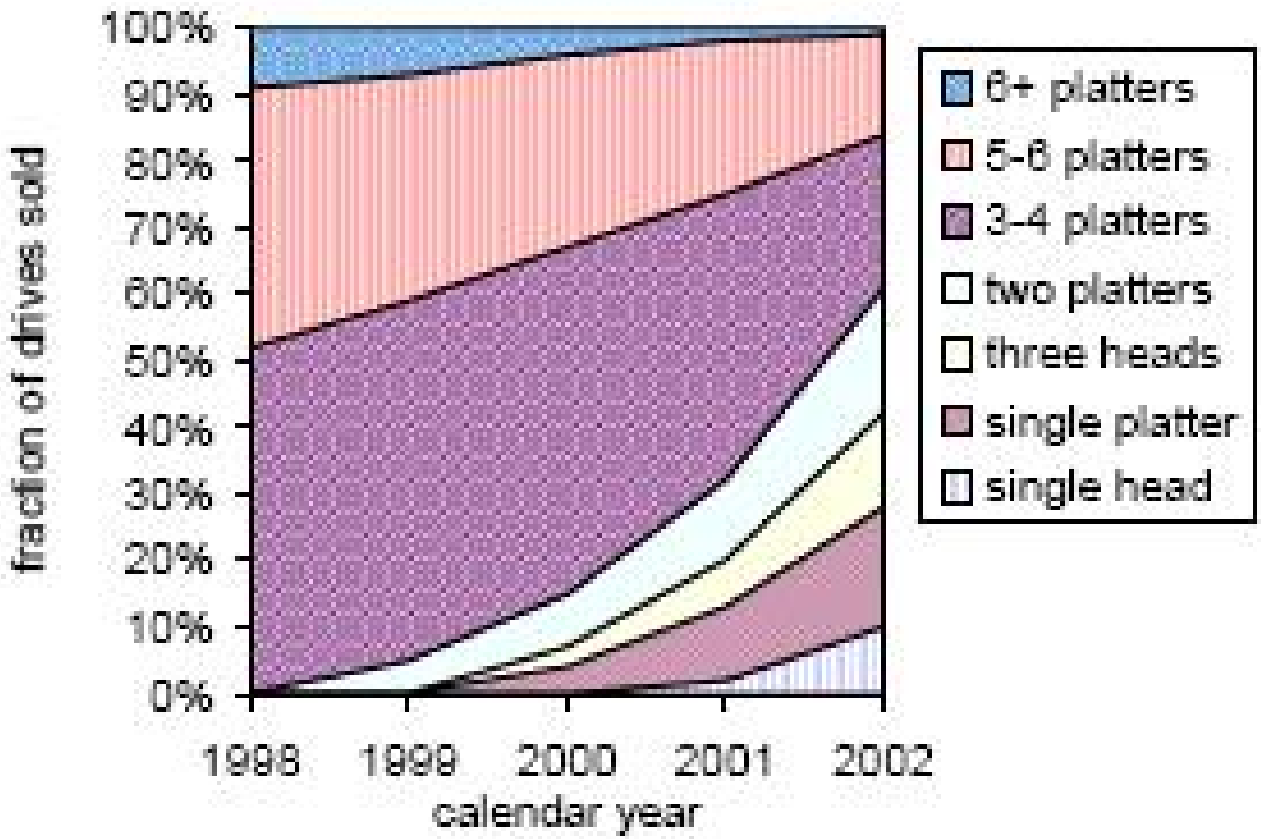
Capacity – Size of Platters

- ✓ 15,000 rpm drives use 2.5″ platters to support the faster spindle speeds
- ✓ 7,200 rpm drives use 3.7″ platters
- ✓ ES drive uses more platters to achieve the same capacity as a PS drive
- ✓ The smaller platters two performance advantages :
  - ability to spin faster and faster seeking
  - random access much faster than PS drive

Performance Differences

Capacity – Number of Platters

- ✓ Fewer platters have less heads ➔ faster seeks



Performance Differences

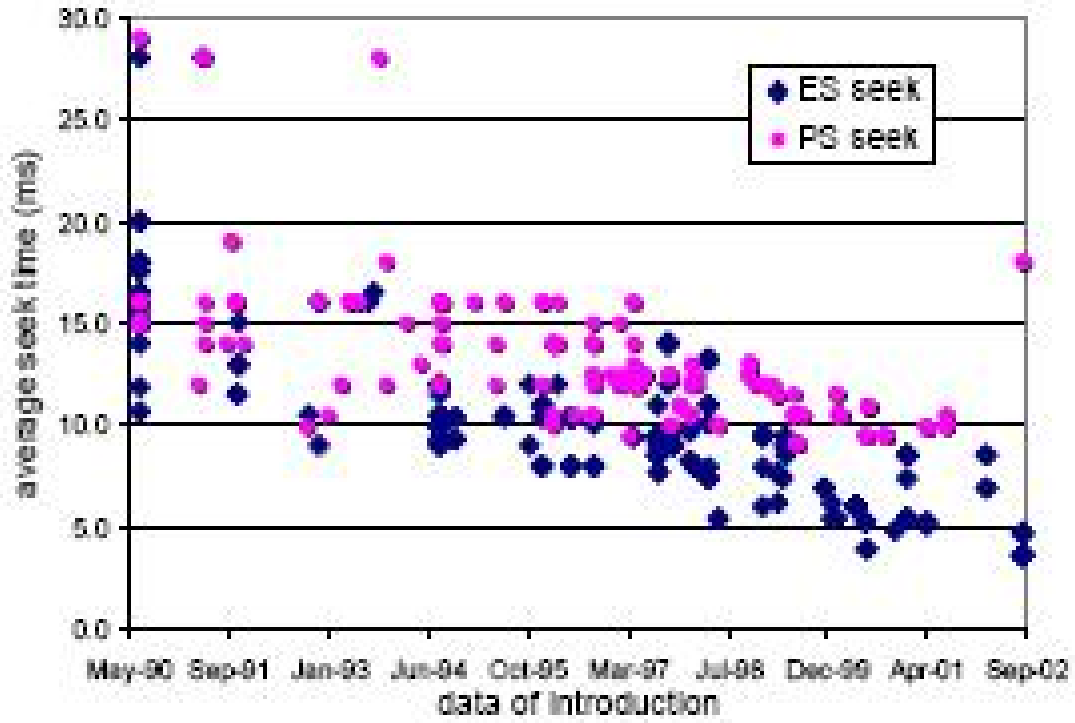
Capacity – Data rate

- ✓ ES drives have higher data rate than a PS drive
- ✓ However, PS drive has an advantage in media size
  - ✓ PS drive : 80 mm (3.3″), 95 mm (3.7″) platters in 10,000 rpm
  - ✓ ES drive : 65 mm (2.5″) platter in 15,000 rpm
- ✓ The larger media size helps the PS drives follow closely in data rate

Performance Differences

Random performance – Seek times

- ✓ Seek performance of PS drives always lags that of ES drives



Performance Differences

Random performance – Seek times

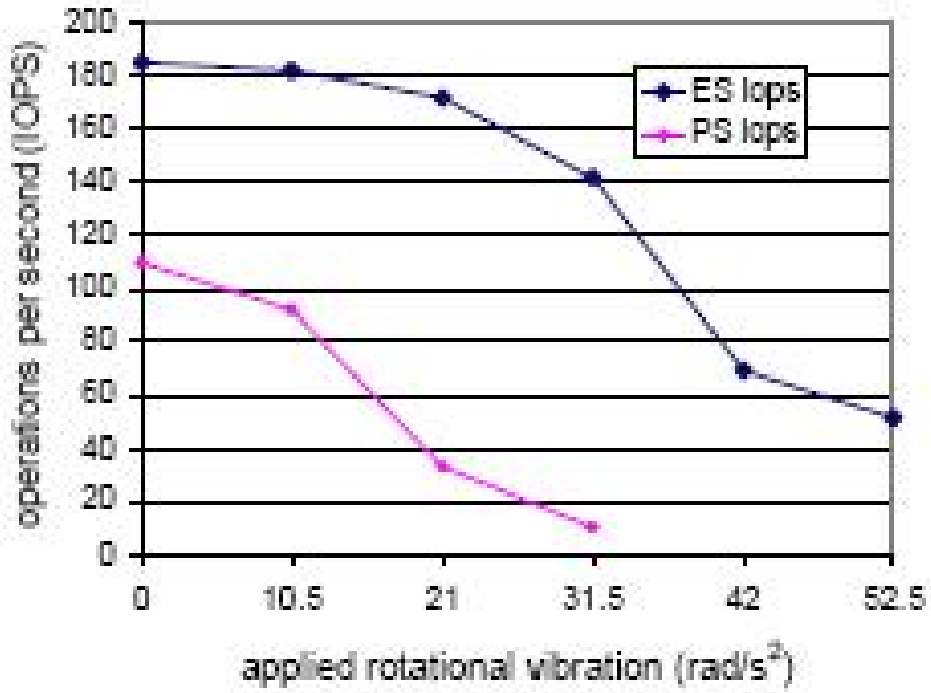
✓ ES drive is focused on achieving the highest random access performance

queue depth	read (8 KB)		write (8 KB)	
	PS	ES	PS	ES
1 requests	65 req/s	115 req/s	105 req/s	184 req/s
2 requests	66 req/s	116 req/s	105 req/s	184 req/s
4 requests	71 req/s	146 req/s	105 req/s	187 req/s
8 requests	79 req/s	174 req/s	105 req/s	190 req/s
16 requests	89 req/s	202 req/s	108 req/s	200 req/s
32 requests	101 req/s	235 req/s	108 req/s	213 req/s

Performance Differences

Random performance – Rotational vibration

- ✓ Since PS drives are built to be in single drive systems ➔ not an important factor
- ✓ ES drives are designed to operate in cabinets full of spinning drives



Performance Differences

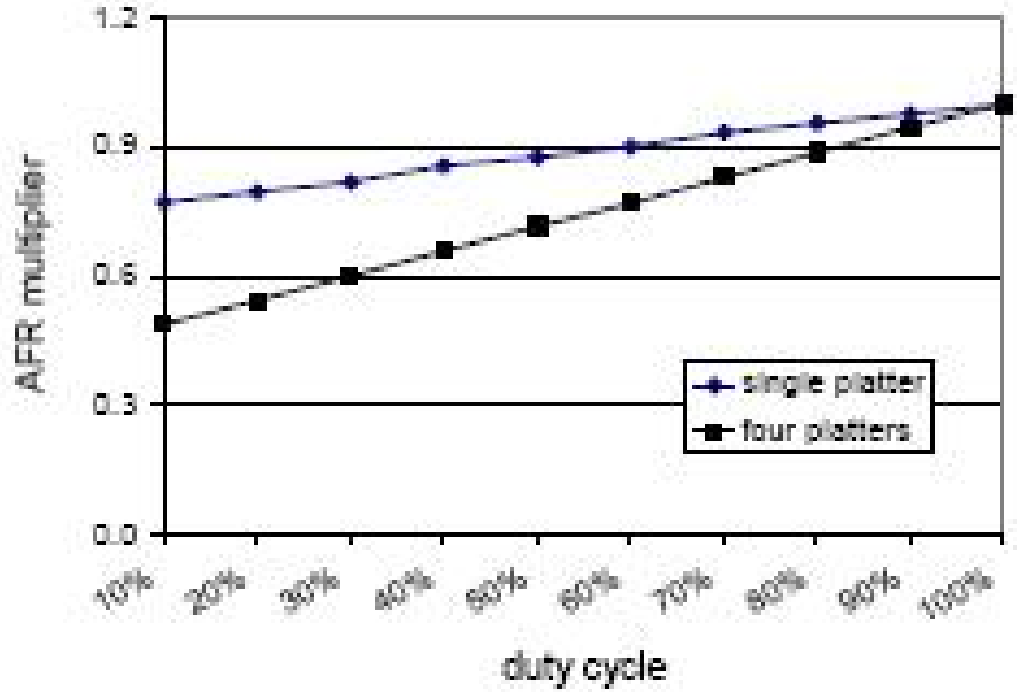
Reliability

- ✓ MTBF
  - ✓ PS drives : 8 hours/day for 300 days/year
  - ✓ ES drives : 24 hours/day for 365 days/year

Performance Differences

Reliability – Duty cycle

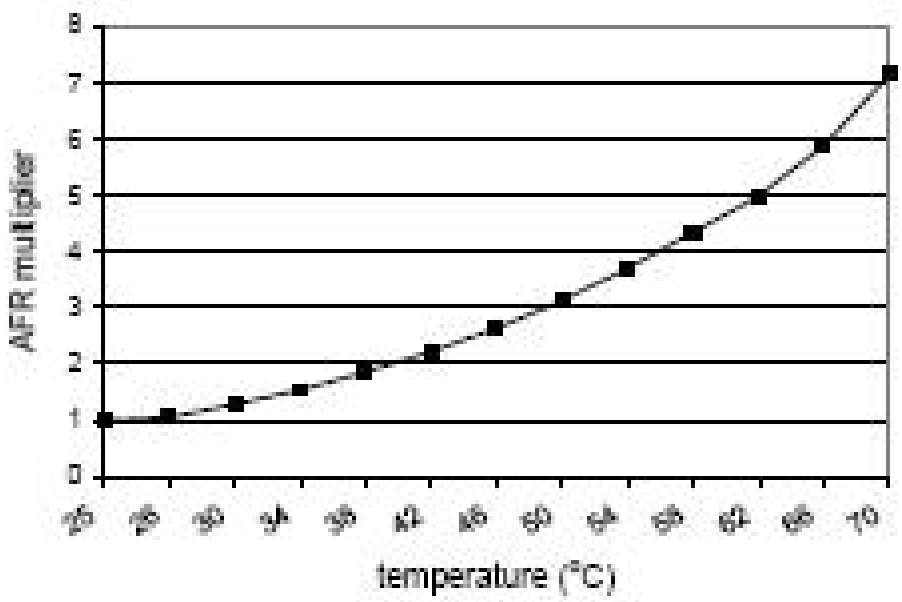
- ✓ Reliability is decreased with higher duty cycle
- ✓ The effect is greater for drives with larger numbers of platters



Performance Differences

Reliability – Temperature

- ✓ Reliability decreases with increases in ambient temperature
- ✓ To prevent contain temperature sensors



Performance Differences

Reliability – Overall reliability

- ✓ Reported a failure rate[Talagala99] :
  - ✓ 25 % for 24 IDE drives
  - ✓ 2 % for 368 SCSI drives

Summary and Discussion

Summary

- ✓ Data rate is proportional to spindle speed, areal density, and platter size
- ✓ Fast seeks more and target the enterprise market (cost extra)
  - include large magnets, better bearings, and stiffer actuators
- ✓ Protection from rotational vibration (cost extra)
  - includes better motors, top covers, stiffer actuators
- ✓ Better scheduling (cost extra)
  - requiring more code space, more memory for re-order queues or algorithm

Summary and Discussion

Summary

- ✓ Interface electronics (cost extra)
  - more customer-modifiable options and host connectivity
- ✓ As a result, High reliability requires cost extra

Conclusions

ATA vs. SCSI

- ✓ They derive from the different requirements of the respective markets
  - ✓ PS drive : lower cost
  - ✓ ES drive : faster random access

Question and Answer