

**Fourth Era of the Hard Disk Drive  
(Small Form Factor HDD & Consumer Electronics Market)**



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- **Hitachi Global Storage Technologies Outline**
- **4<sup>th</sup> Era of HDD and Market Environment**
- **Hitachi's Microdrive Leading the 4<sup>th</sup> Era**

# Hitachi Global Storage Technologies Outline

## Hitachi Global Storage Technologies

2003 revenue 4.2 Billion US\$  
24,453 Employees(as of June'04)  
(including 1,557 R&D Personnel)  
Industry's largest patent portfolio

### Headquarter

- San Jose, California

### Research & Development

- Fujisawa / Odawara, Japan
- San Jose / Rochester, USA

### Manufacturing Locations

- Thailand
- Philippine
- China
- Singapore
- Mexico
- Japan (Odawara)
- USA (San Jose)

### Logistics Centers

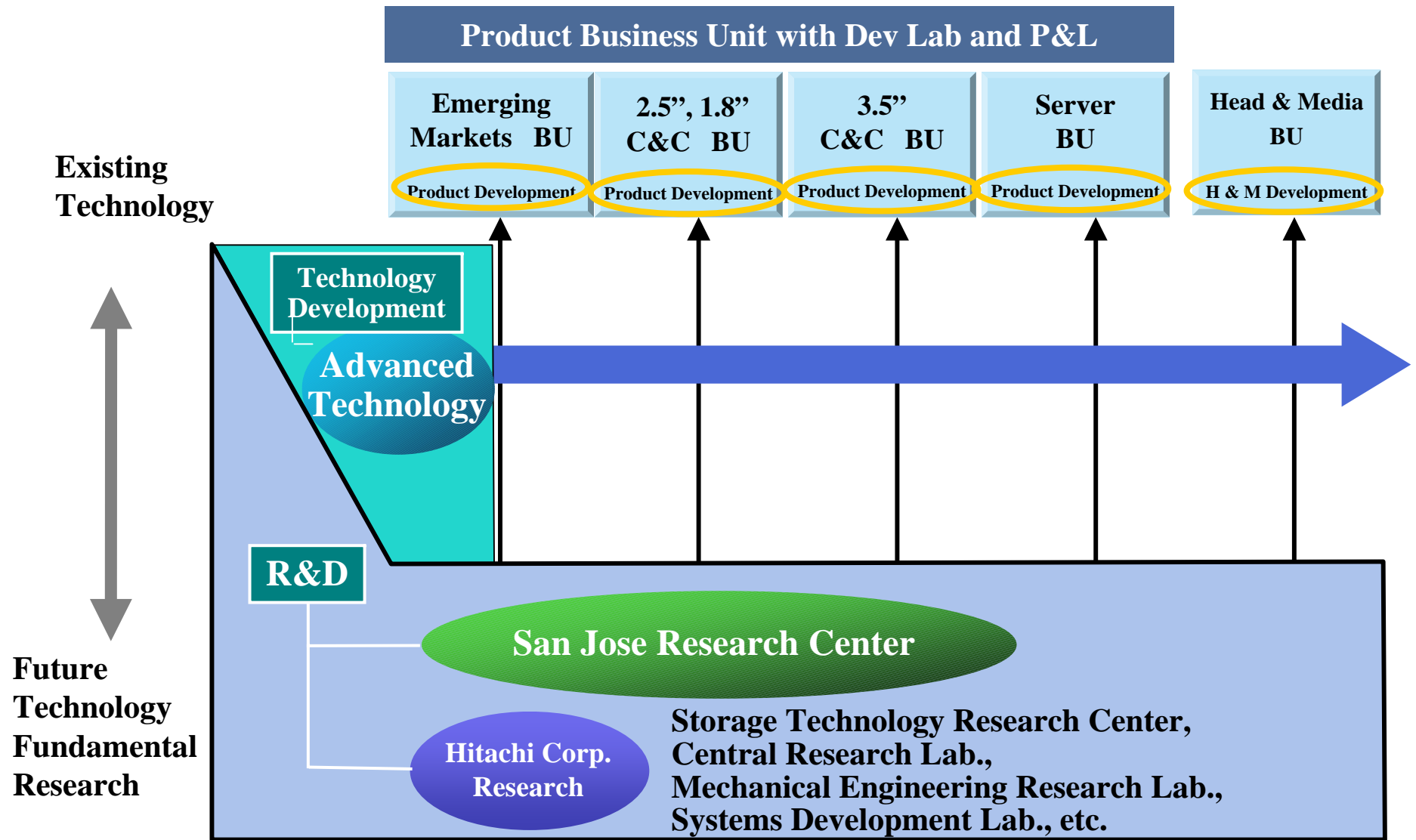
- Singapore
- California
- Netherlands
- Taiwan

### Customer Test Centers

- UK
- Taiwan
- USA
- Japan

**Sales Offices  
Located WW**

# Business Unit Concept & Global R&D



# Rich Product Family

## Travelstar

5K80

80/60/40/20 GB

2.5"

5400 RPM, 70 Gb/in<sup>2</sup>

7K60 / E7K60 (24x7 apps)

60/40 GB

7200 RPM, 50 Gb/in<sup>2</sup>



4K80

80/60/40/30 GB

4200 RPM, 68.5 Gb/in<sup>2</sup>



4K40

40/30/20 GB

4200 RPM, 70 Gb/in<sup>2</sup>

80GN

80/60/40/20 GB

4200 RPM, 70 Gb/in<sup>2</sup>

1.8"

C4K60

30/20 GB;

4200 RPM 99.8 Gb/in<sup>2</sup>

500G/2ms operating shock



2.5", 1.8"  
C&C BU

## Ultrastar

10K300

300 / 147 / 73.4 / 36.7 GB;  
10K RPM, 61 Gb/in<sup>2</sup>, SCSI, FC

DK32EJ

147.8 GB 73.9 GB 36.9 GB

10K RPM. 30 Gb/in<sup>2</sup>

15K73

73.9 / 36.9 GB

15K RPM 31 Gb/in<sup>2</sup>



146Z10

146.8/73.4/36.7/18.3 GB

10K RPM, 26.2 Gb/in<sup>2</sup>



Server  
BU

## Deskstar

7K400

400 GB ATA, SATA  
7200 RPM 62 Gb/in<sup>2</sup>

7K250

250/200/160/120/80/40 GB

7200 RPM, ATA, SATA, 77-90 Gb/in<sup>2</sup>



180GXP

180/120/80/60 GB

7200 RPM, 45.5 Gb/in<sup>2</sup>

7K80

80/40 GB, ATA

7200 RPM 62 Gb/in<sup>2</sup>



3.5"  
C&C BU

## Endurastar

J4K20/N4K20

20 GB. 4172 RPM, 37.7 Gb/in<sup>2</sup>

-20C => 85C operating



Emerging  
Markets BU

## Microdrive

3K4 digital media

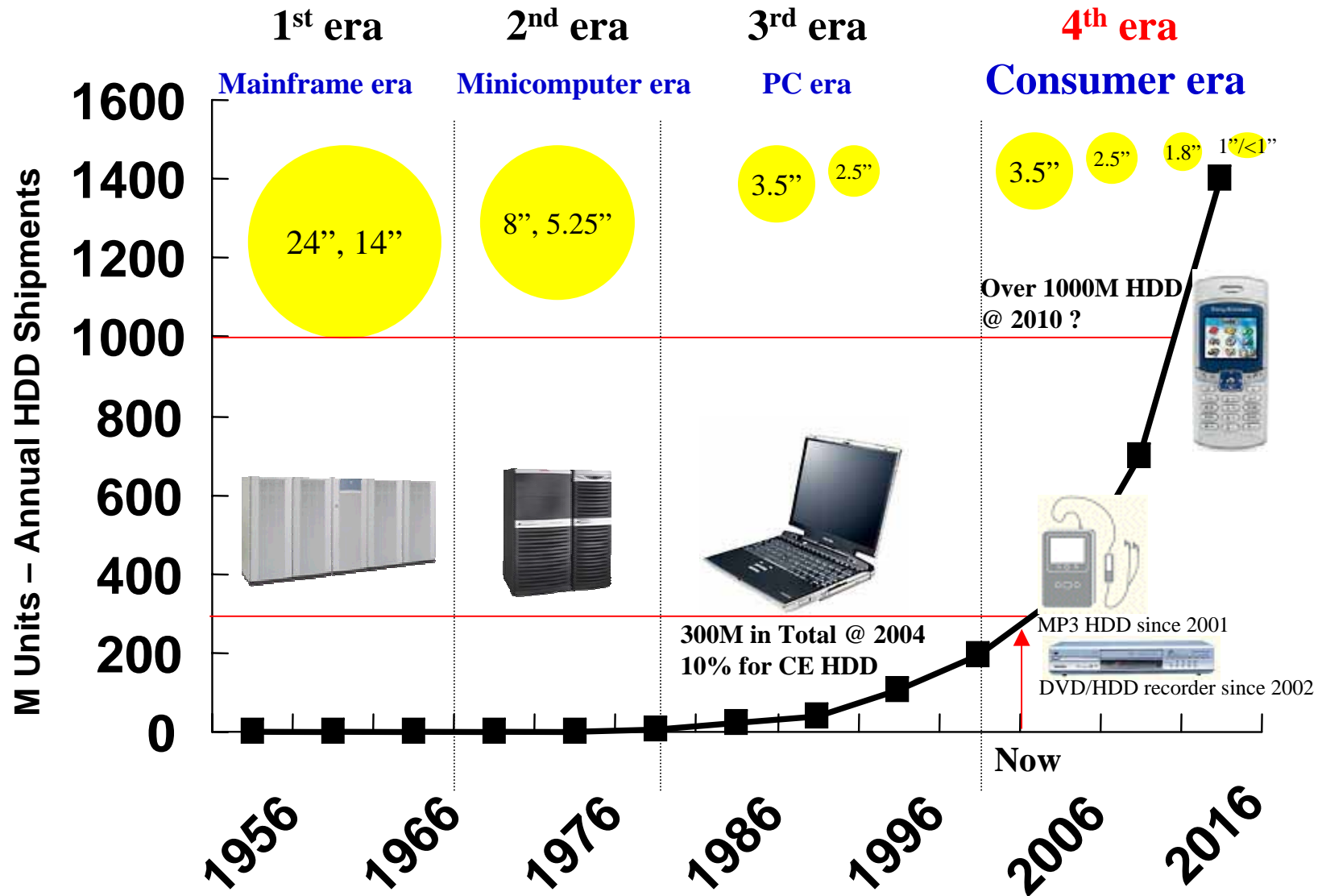
4/2 GB, 3600 RPM, 56.5 Gb/in<sup>2</sup>

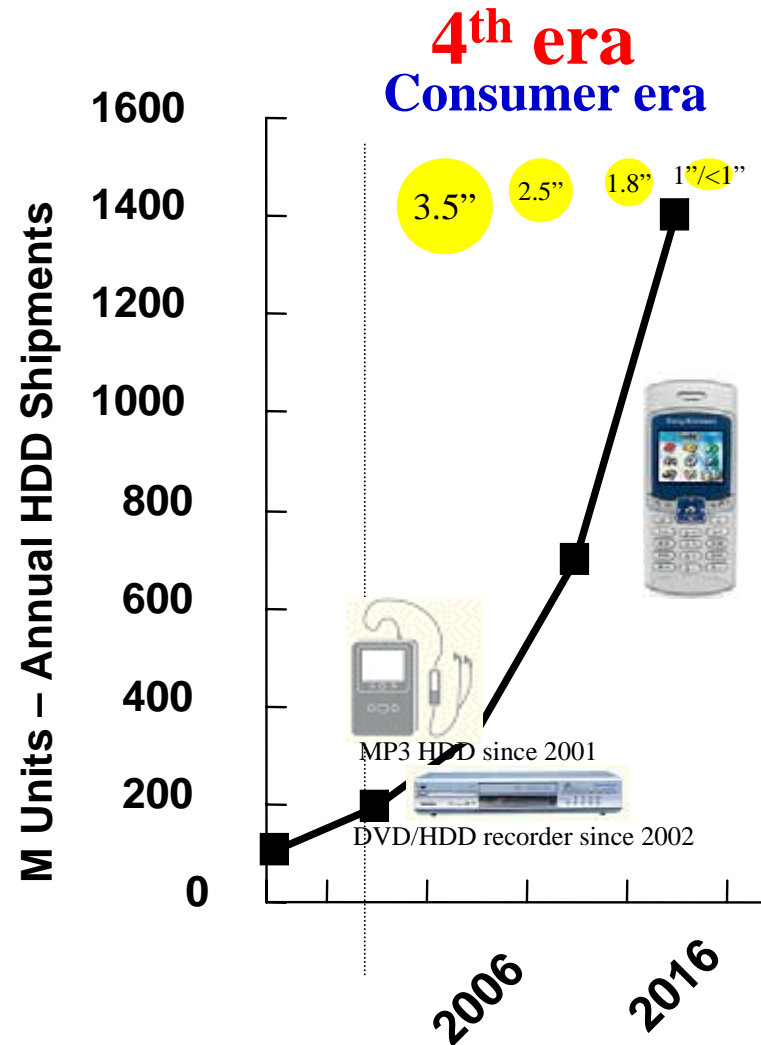


Emerging  
Markets BU

# 4<sup>th</sup> Era of HDD and Market Environment

# Fourth era of HDD





## Key Driving Factors

### 1. HDD technology evolution

- a. Price per Capacity
- b. Capacity with Small Form Factor HDD

### 2. Mobile HDD Applications for more storage

- a. MP3 with download music
- b. Mobile phone with multi functions

### 3. Infrastructure(Network & Broadcast)

- a. Broadband Network
- b. Digitalization of media content
- c. Terrestrial digital broadcast

⇒ TV on Mobile phone(1segment BC)

# Drive Miniaturization

## 1956 RAMAC

- 5 Mbytes
- Fifty 24" disks, 1200 RPM
- 2000 bits/in<sup>2</sup>



48 years ago

20 years ago



## 3380

- 1.2 GB >1000W
- Nine 14" disks, 3600 RPM
- 12 Mb/in<sup>2</sup>

Now

## 2.5" Mobile

- 80 GB 850 / 100 mW (idle/sleep)
- Two 2.5" disks, 5400 RPM
- 70 Gb/in<sup>2</sup>

## Microdrive

- 4 GB 220mW / 43 mW (idle/standby)
- One 1" disk, 3600 RPM
- 56.5 Gb/in<sup>2</sup>

25kg

1/1562 weight  
>3.3 capacity

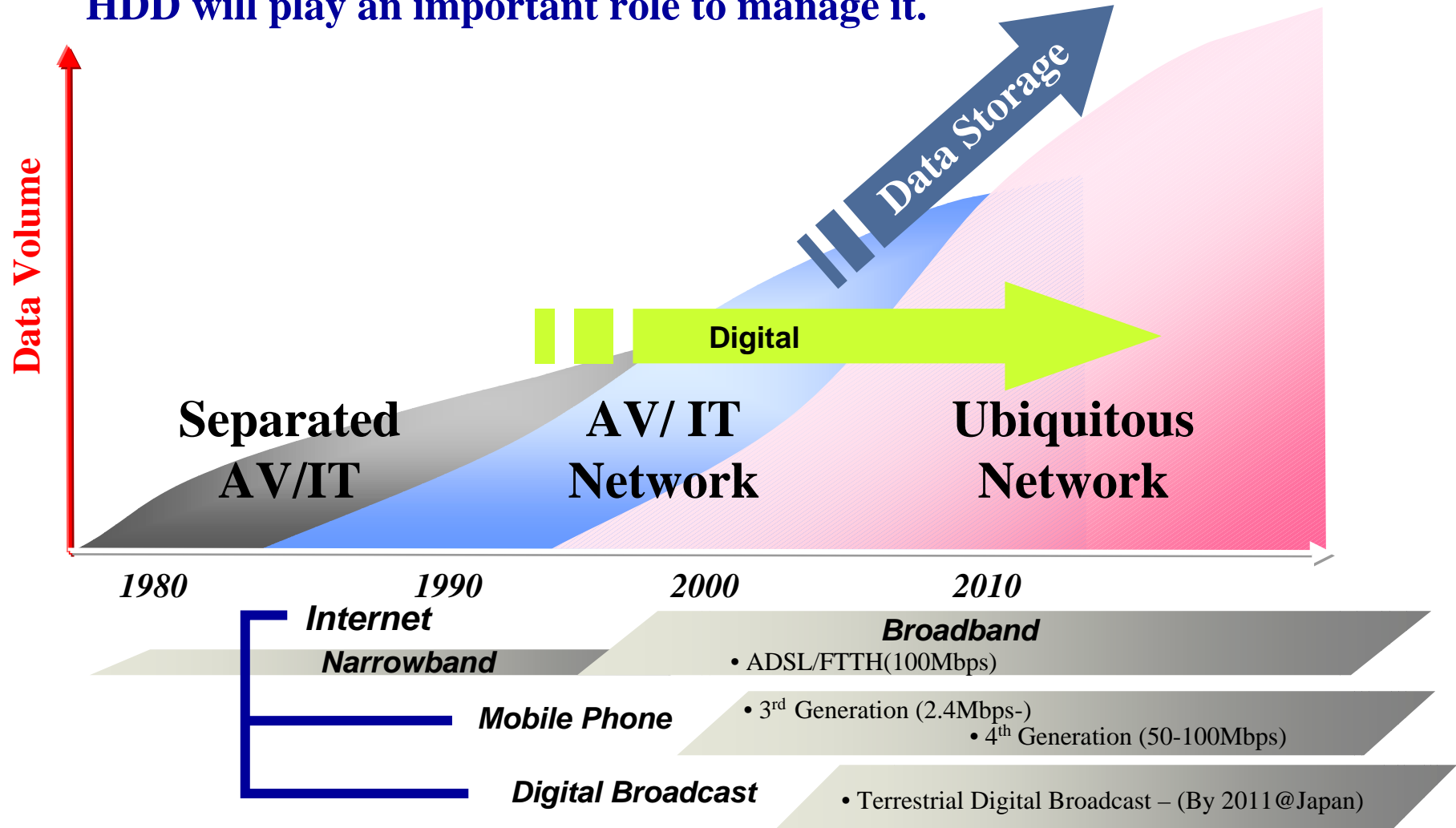


16g

The HDD evolution leads to acceptable Capacity, Price and Size for CE devices

# More Data Storage with HDD in Ubiquitous Network

- As the data volume increases in the ubiquitous and broadband world, HDD will play an important role to manage it.

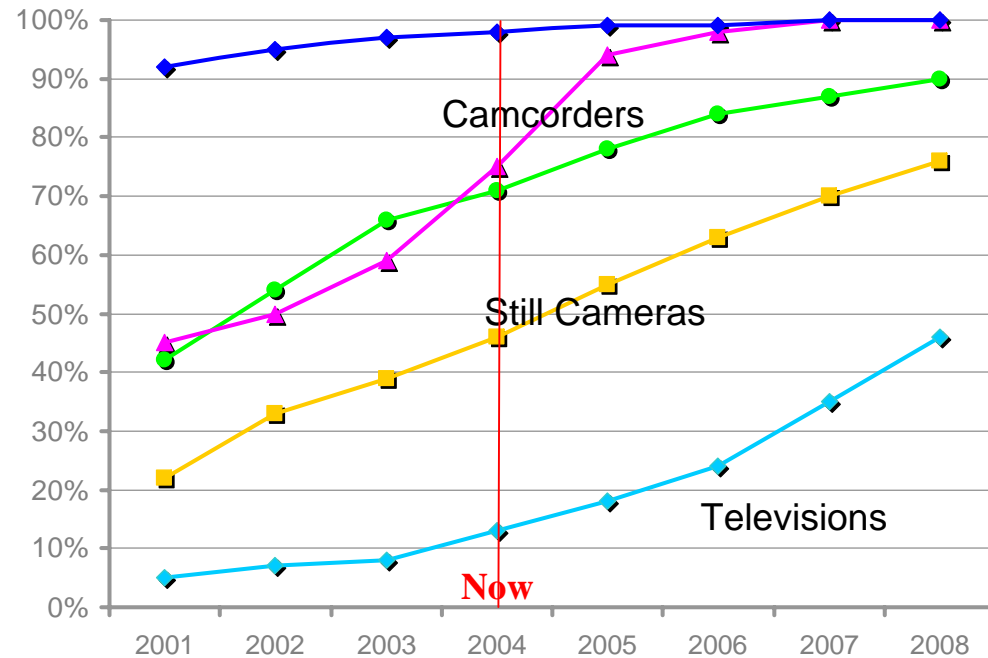




- Set-Top-Boxes
- Camcorders
- DVD vs VHS
- Still Cameras
- Televisions

## Worldwide Digital Penetration

(% of shipments)

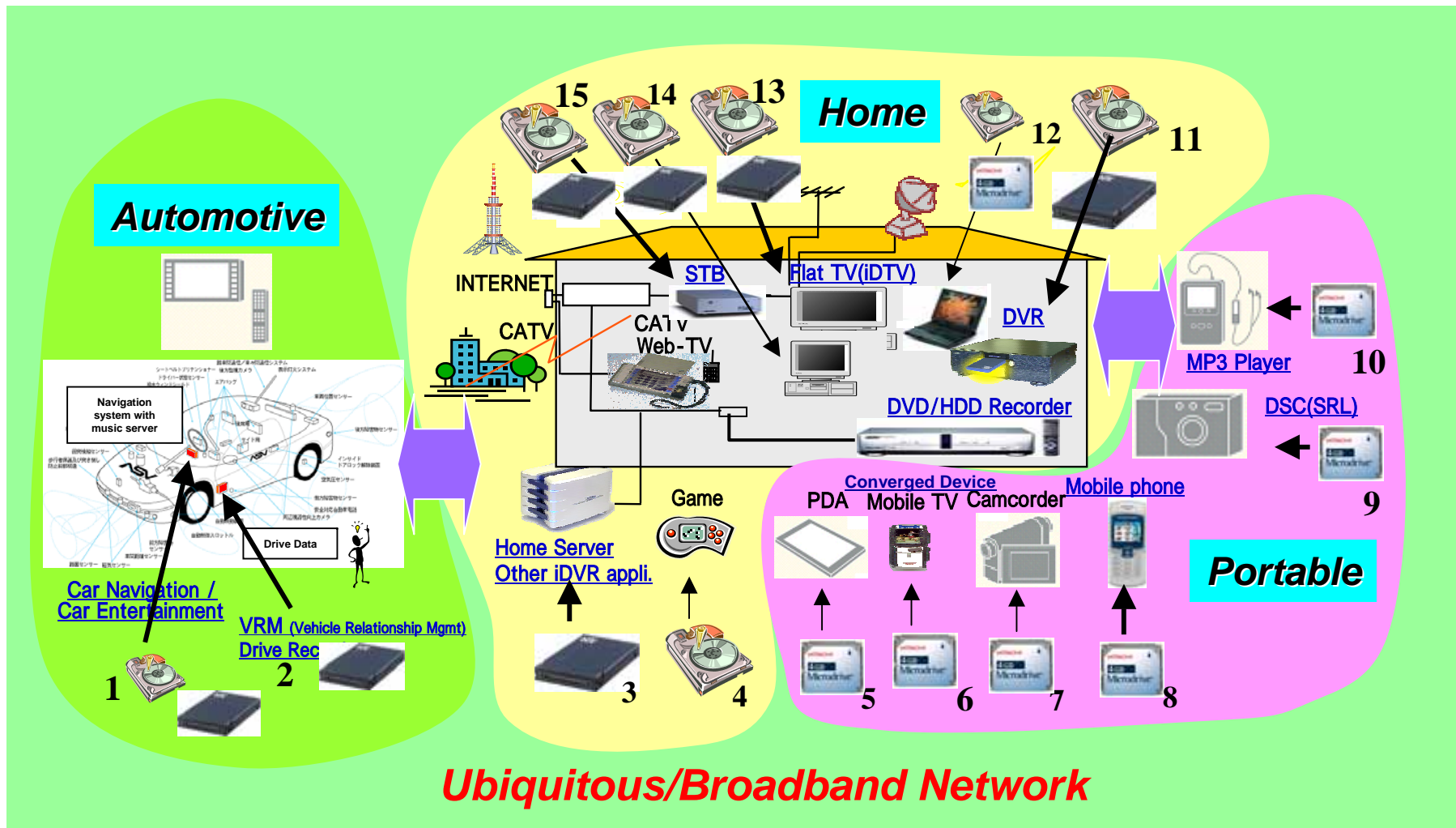


Source: IDC, Morgan Stanley, CBIC World Markets

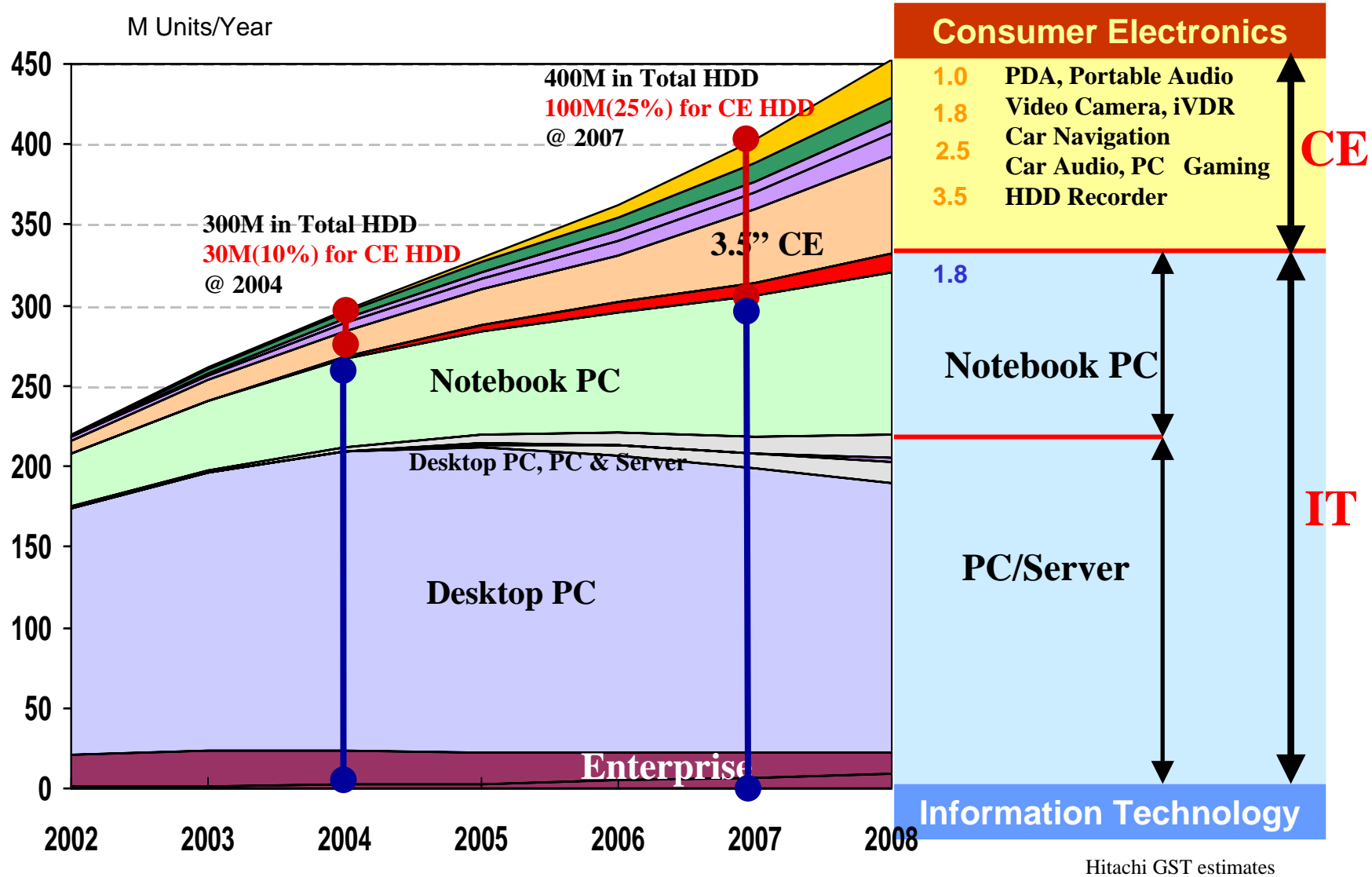
**An increasing fraction of data in Consumer Electronic Devices is digital**

# HDD Usage for Daily Life in near future

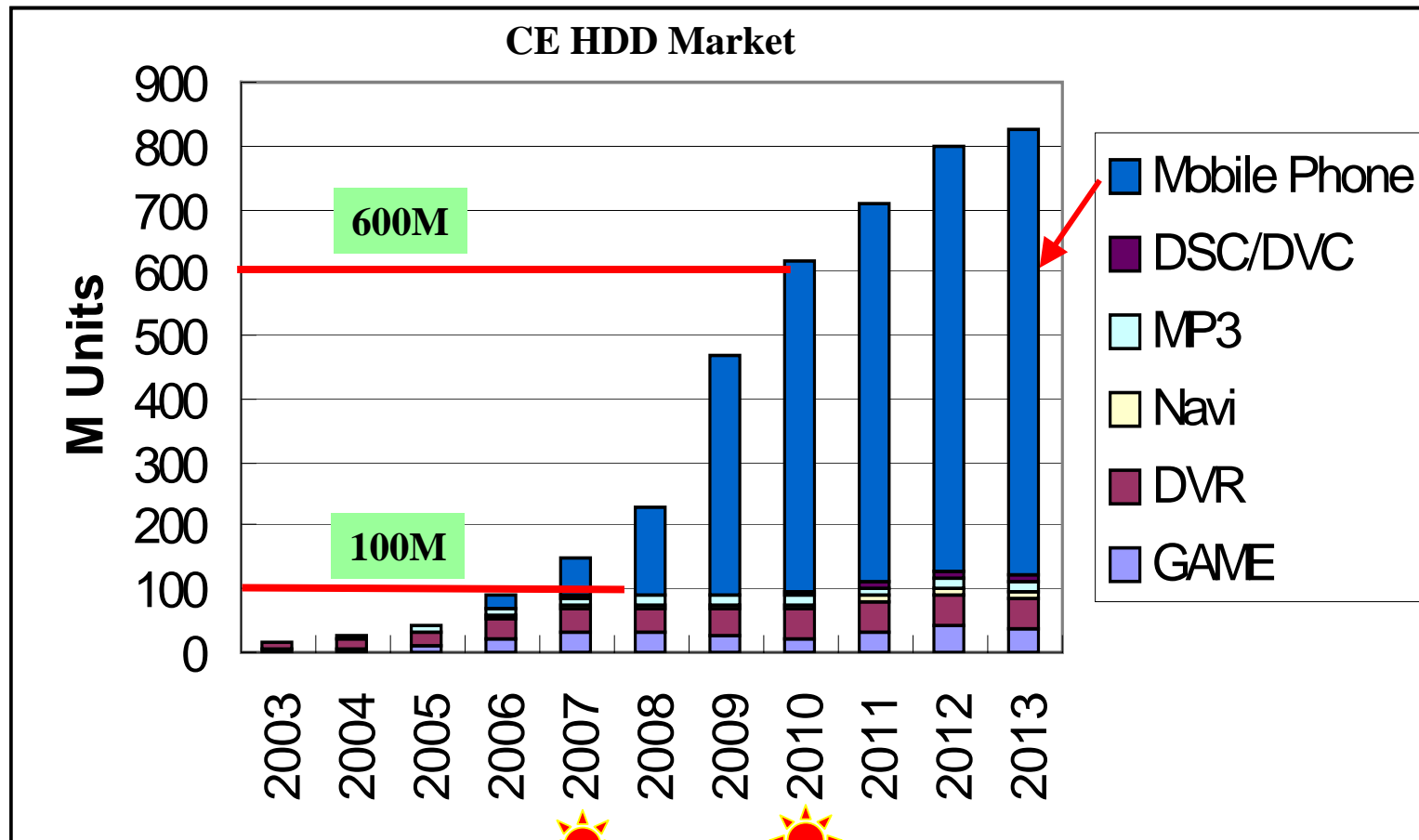
10-15 HDDs per home will be used in near future



# Strong Growth Ahead for Consumer Electronics



**Huge opportunity in Mobile Phone in Future.... but with lots of challenges for HDD**



Source : Institute of Information Technology,Ltd.

## Hitachi's Microdrive Leasing the 4<sup>th</sup> Era

- **History**
- **Technology**
  - ✓ **Shock**
  - ✓ **Power**
- **Capacity per Price**
- **Application**

# Microdrive — A Brief History



**Nov 1997**  
Technology Demo



**Sept 1998**  
Technology Announcement  
CF- II Standard (5mm thick)



**June 1999**  
First Generation (340MB)  
Product Launch



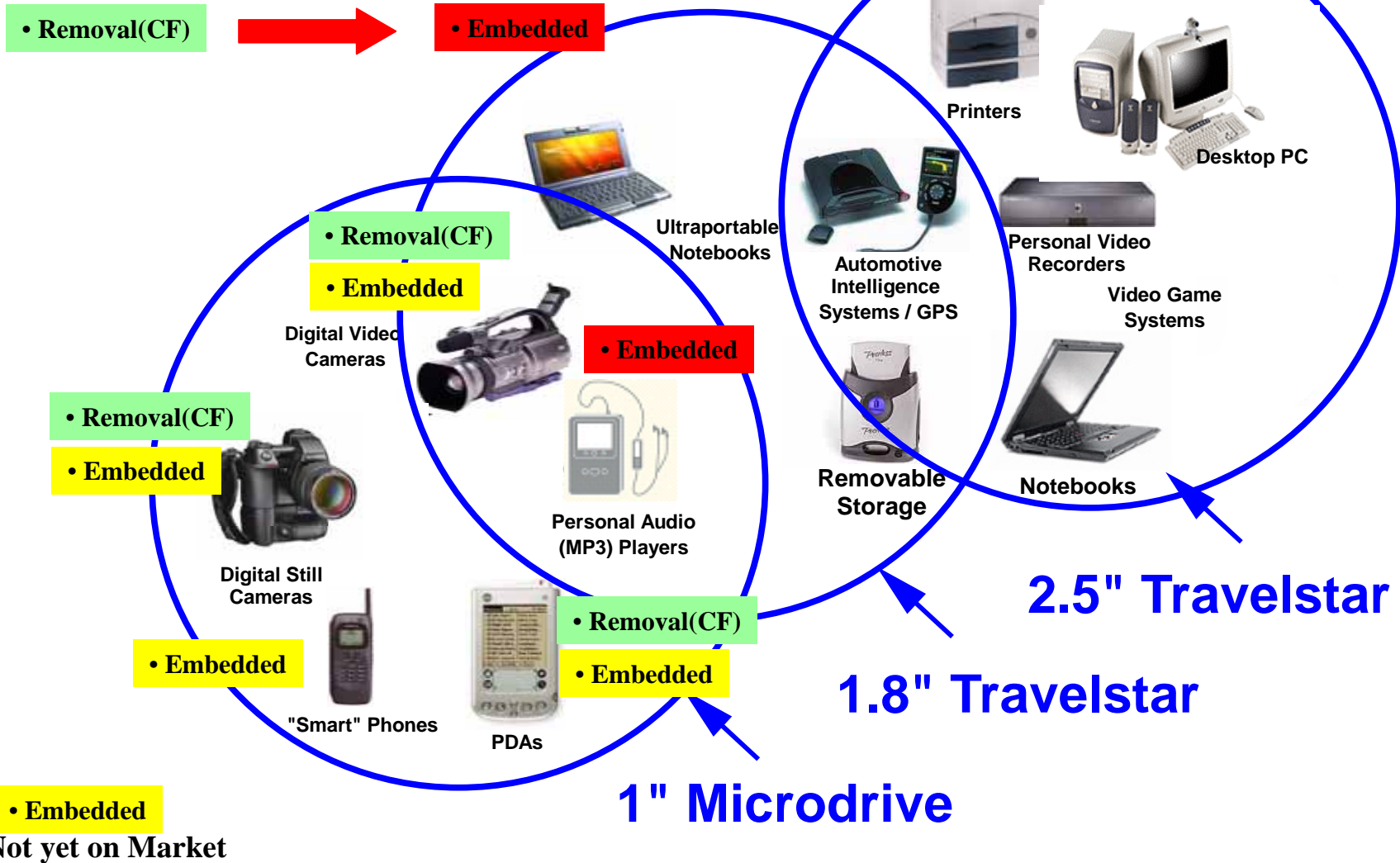
**Aug 2000**  
Second Generation (1GB)  
Product Launch



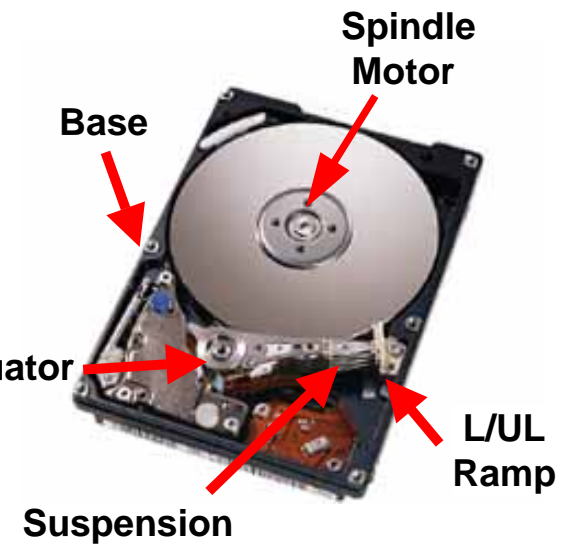
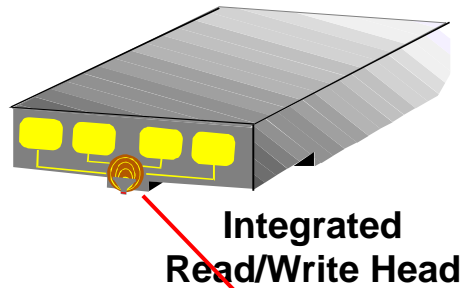
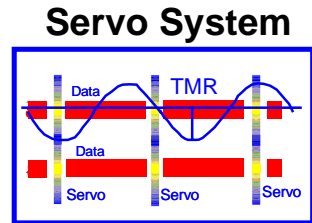
**Aug 2003**  
Third Generation (4GB)  
Product Launch

# Application for HDD Form Factors

## More CE Applications with Embedded Microdrive



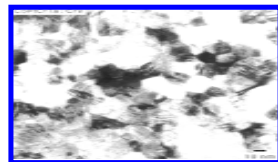
# Hard Disk Drive Technology



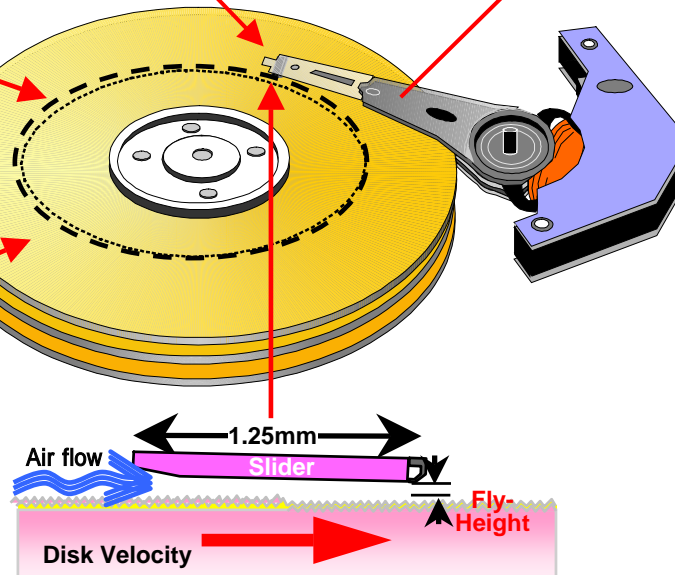
## Track Position Control

- Track width : 254nm
- Track Position Accuracy : 25nm

## Disk

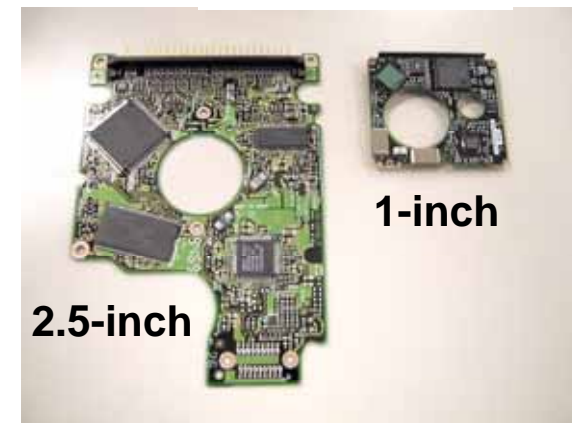


- < controlled 8 nm grain
- 8 to 10 layers in 30 sec



- < 10-14 nm

## Electronic Card



## 4 GB Microdrive HDD from Hitachi in 2003

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- **Product Announcement**  
**August 25, 2003**
- **Volume ramp in 4Q 2003**
- **Capacity 4 GB / 2 GB**
- **Key Features...**
  - Higher capacity
  - Faster data rates
  - Improved shock robustness
  - Improved power management



# 4GB Microdrive Shock Robustness

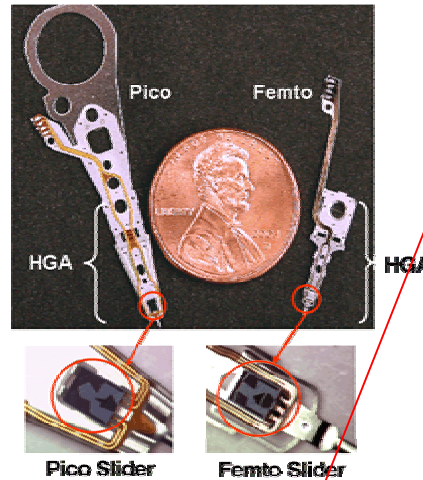
**4GB** In 2003



- L/UL-Ramp
- Actuator Latch
- Shock Sensor
- Top Clamp Design
- Reverse IF Connector Layout
- Servo Design for disk shift
- FDB Spindle motor
- Rubber Frame
- Curved Suspension
- Femto Slider

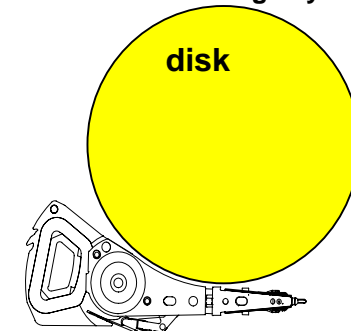
**Non Ope. Shock : 2000G/1ms**  
Criteria No Hard Error (0/4Gbytes)

**Femto slider  
(70% of Pico)**

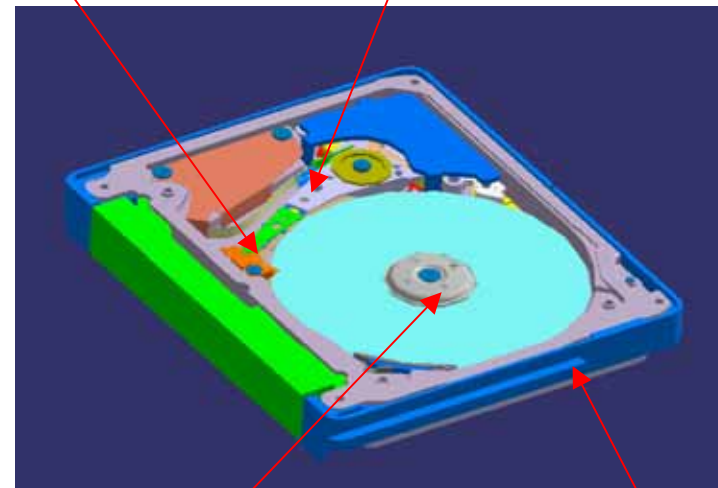


**Curved suspension**

No-overlapping with disk  
to avoid head damage by shock



**Curbed suspension**



**FDB Spindle motor**

**Rubber frame**

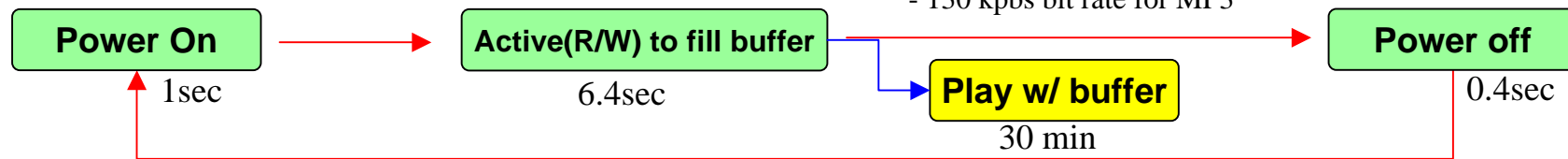
**Shock robustness can improve further with HDD imbedded into device**

# HDD Power Modes

	<u>Channel</u>	<u>Servo</u>	<u>Actuator</u>	<u>Motor</u>	<u>Power (mW)</u>
<b>Active(R/W)</b>	Full	Full	Loaded	Spin	930
<b>Performance Idle</b>	Servo	Full	Loaded	Spin	550
<b>Active Idle</b>	Periodic	Periodic	Loaded	Spin	230
<b>Low Power Idle</b>	Off	Off	Unloaded	Spin	220
<b>Standby</b>	Off	Off	Unloaded	Stop	56
<b>Power off</b>	Off	Off	Unloaded	Stop	0

**Example (To use Active & power off mode for MP3)**

- 32MB system buffer
- 130 kpbs bit rate for MP3



**930mW(100% Duty) → 3.73mW(0.4% Duty)**

**Actual power consumption is very small due to small duty**

# HDD Power Modes for AV Applications

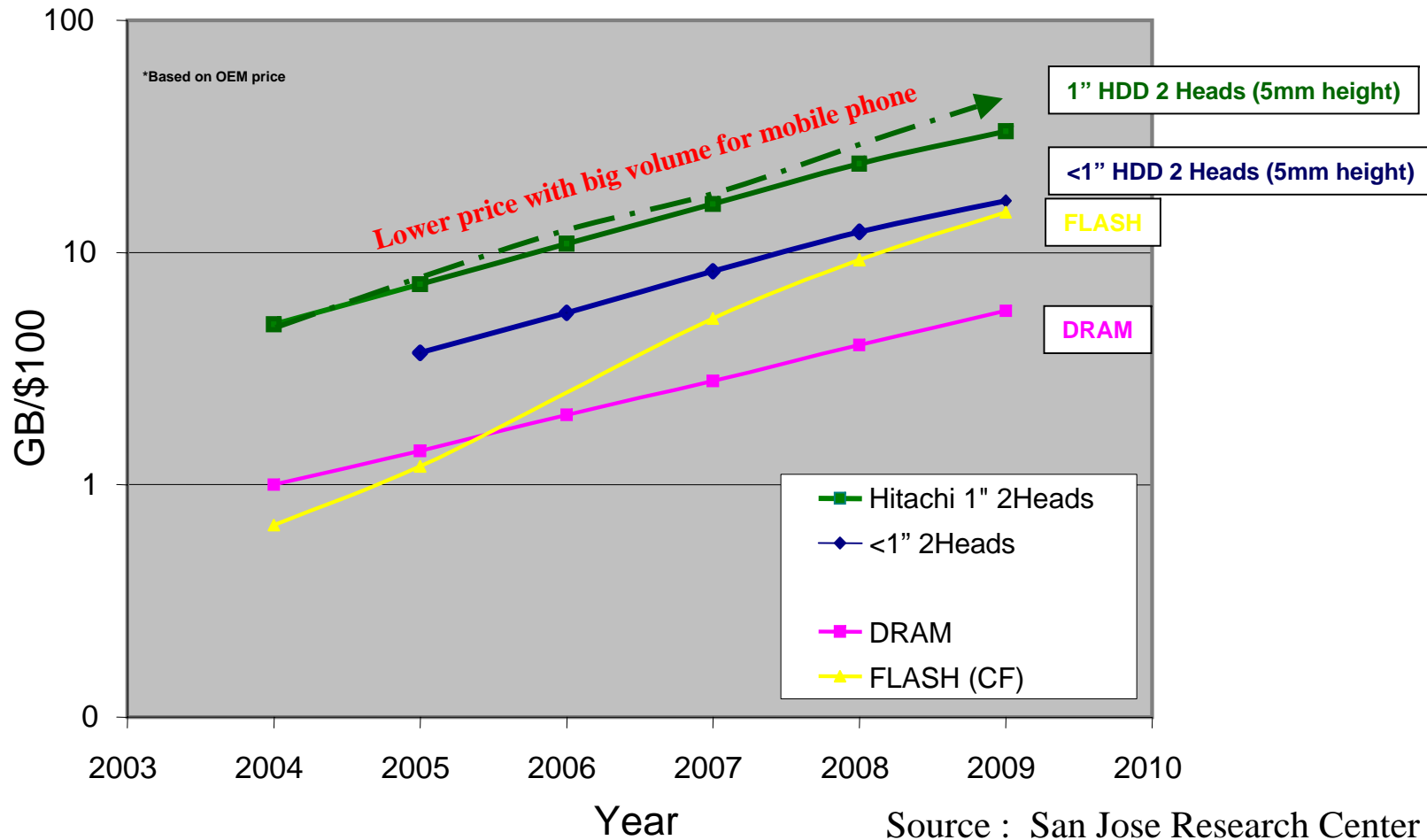
Application			Bit rate (kbps)	Duty (w/ 32MB System Buffer)	HDD Ave.Power (4GB microdrive)
MP3			130	0.4%	3.73mW
MPEG-4 Mobile Movie	QVGA	Motion picture on Mobile phone	390	1.2%	10.78mW
MPEG-4 SDTV	VGA	TV play on Mobile phone	3000	10.1%	81.57mW
MPEG-2 SDTV	VGA	DVD play	4000	13.9%	108.69mW
HDD Read/Write				100%	930mW

To be reduced

**Power can be saved a lot for AV applications with HDD power mode**

# Capacity per Price : FLASH vs. Small HDDs

Projected Capacity per \$100 for Major Memory Types



**1" HDD will keep price advantage per capacity against Flash.**

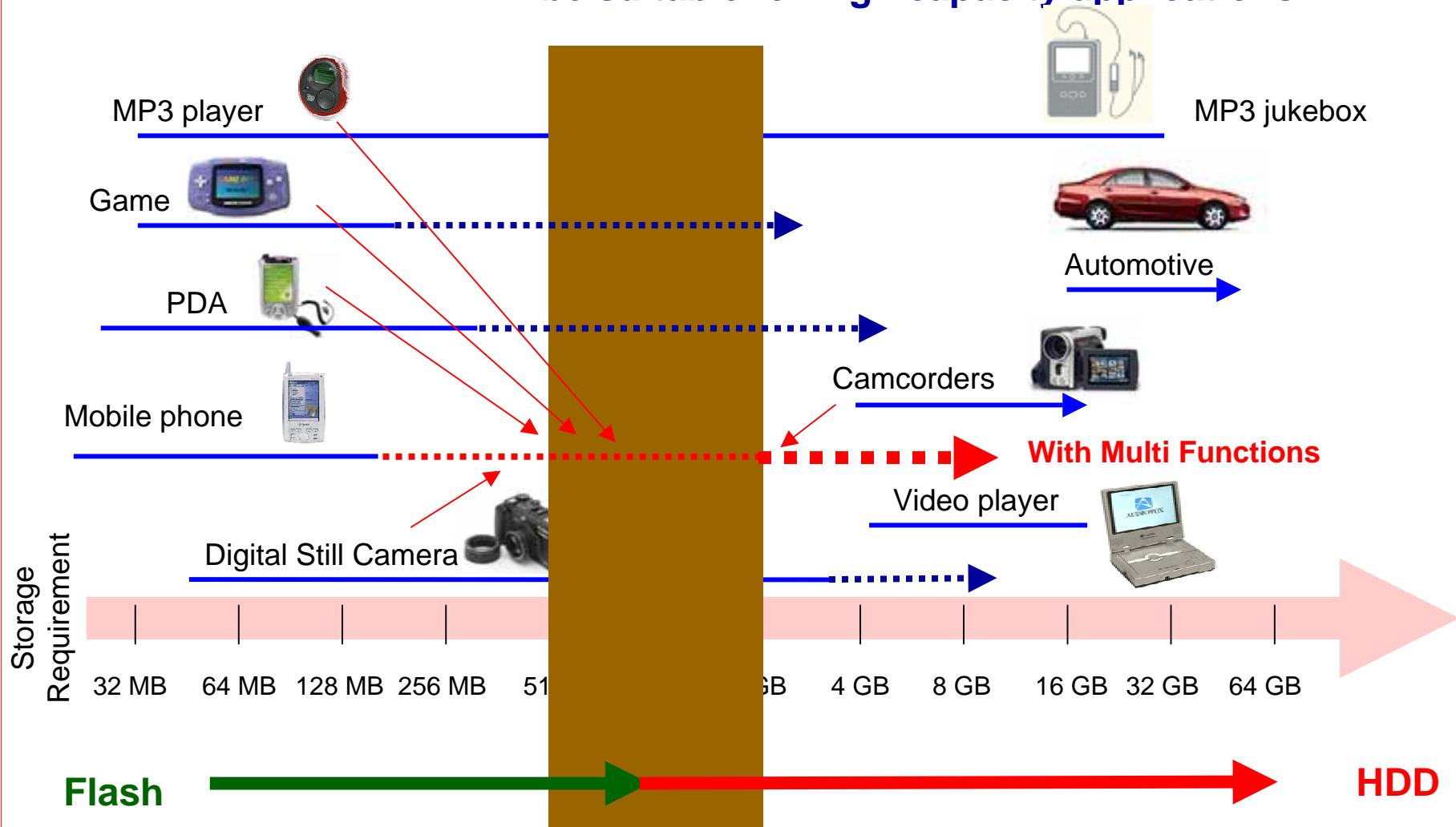
**1" HDD best fitting for Mobile device that demands capacity.**

	1" HDD	<1"HDD	Flash
Size	○ W/ Better Integration	◎ DE=SD Card foot print	◎◎ Mini-SD,RS-MMC,T-flash,
Capacity	◎	○ Half of 1"HDD	△
Capacity per Price	◎	○ Challenged by Flash	△
Power Consumption	○ Saving w/power mode Similar to <1"HDD	○	◎
Shock Robustness	○ Improvement w/ Embedded HDD	○	◎

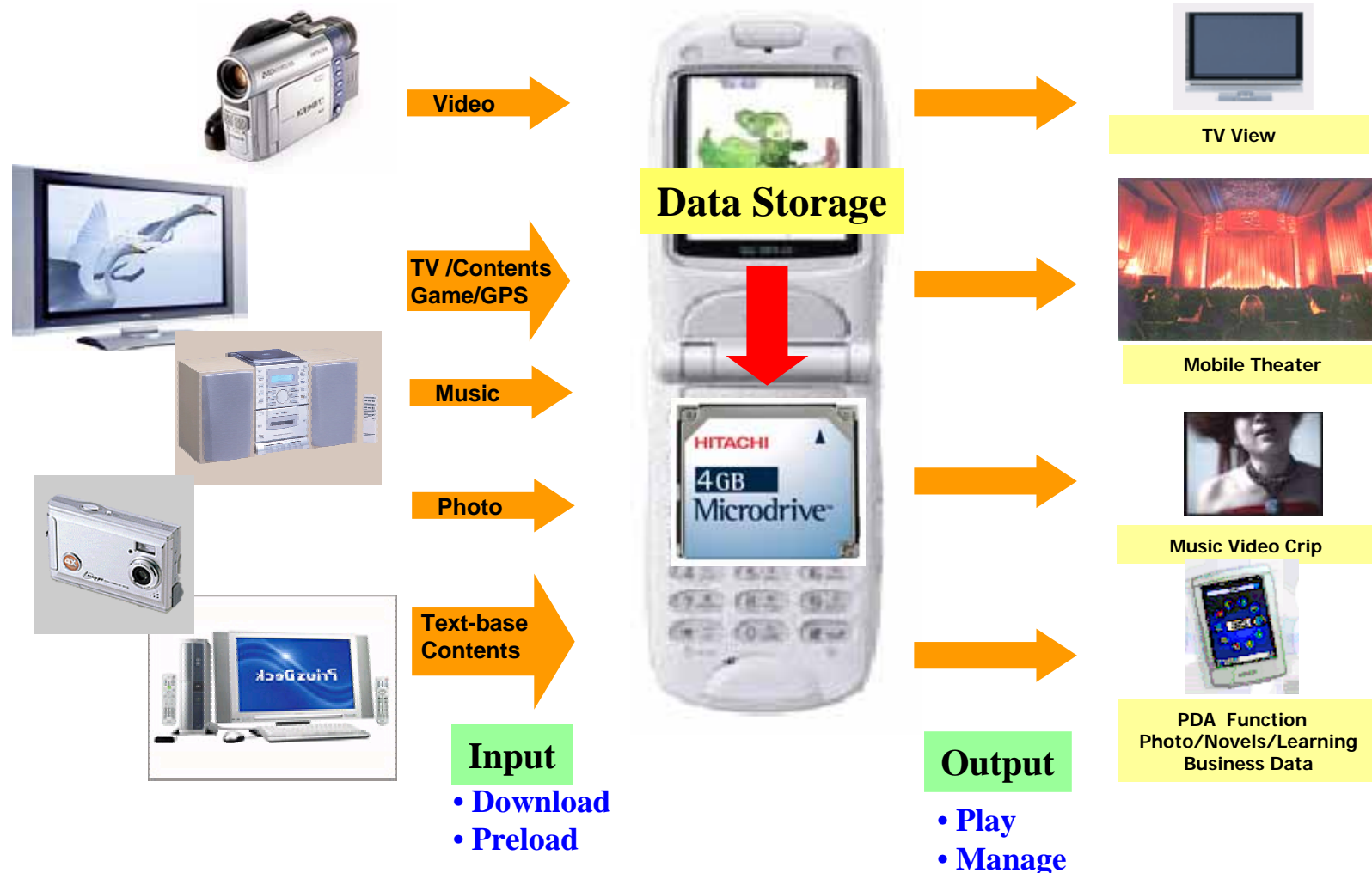
# Portable Consumer Digital Devices

— current  
- - - future

**Flash use in CE will continue to grow, but HDD will be suitable for high capacity applications.**



# Mobile Phone(Converged Device) with Multi Functions



**Small Form Factor HDD will be a key component for mobile phone with multi functions.**

- Small Form Factor HDD Demand to explode in 4<sup>th</sup> era of HDD.
- The Biggest opportunity is in Mobile Phone applications.



- Hitachi is the leader for 1" HDD with more than 5 years experiences.
- Hitachi is committed to growing Microdrive supply.
  - ✓ \$200M investment in Thailand MFG
  - ✓ Part of this investment has gone to increasing Microdrive manufacturing lines
  - ✓ Have substantially increased volume supply since the start of 2004.
- Hitachi is committed to more Microdrive products in the future
  - Capacity increase and cost reduction for better capacity per price
  - Improvements in key functions such as power consumption, shock...
  - Working with leading OEMs in each market segment for better integration

# Thank You !

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