

Designing Embedded Systems



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Basic Architectures

Control Unit

- Custom logic
- FPGAs (Field-Programmable Gate Arrays)
- Microcontrollers
- **Microprocessors**
- DSPs (Digital Signal Processors)
- ASIPs (Application Specific Instruction-set Processors)
- Multicore? (symmetric vs. asymmetric)
- Typical word size: 8/16/32-bit

Why Microprocessors?

- **Microprocessors**
 - ARM, MIPS, PowerPC, SuperH, Cell, Atom, ...
 - Mostly less than 1 GHz
- **Microprocessors are often very efficient:**
 - Can use same logic to perform many different functions
- **Microprocessors simplify the design of families of products**

The Performance Paradox

- Microprocessors use much more logic to implement a function than does custom logic
- But microprocessors are often at least as fast:
 - Heavily pipelined
 - Large design teams
 - Aggressive VLSI technology, ...

Power

- Custom logic uses less power, but CPUs have advantages:
 - Modern microprocessors offer features to help control power consumption
 - Software design techniques can help reduce power consumption
- Heterogeneous systems
 - Some custom logic for well-defined functions, CPUs + software for everything else

RAM

- **SRAM**
 - Easier to integrate on the same chip as processor
- **DRAM**
 - SDRAM (Synchronous DRAM): SDR/DDR/DDR2/DDR3
 - Mobile SDR/DDR SDRAM
 - RDRAM (Rambus DRAM)
- **NVRAM (Non-Volatile RAM)**
- **Future NVRAMs: PRAM, MRAM, FeRAM**
- **Cache memory**
- **SPM (Scratch Pad Memory)**

ROM

- Mask-programmed
 - Connections programmed at fabrication
- OTP (One-time programmable) ROM
 - Connections programmed after manufacture by user
- EPROM (Erasable programmable ROM)
- EEPROM (Electrically erasable programmable ROM)

Flash Memory

- NOR Flash
- NAND Flash
- Fusion memory: OneNAND Flash
- e-MMC: MoviNAND, iNAND
- Cards (MMC, SD, CF, ...)

Interfacing

- ARM AMBA (Advanced Microcontroller Bus Architecture)
- ISA (Industry Standard Architecture)
- PCI (Peripheral Component Interconnect)

- I²C (Inter-IC) bus
- USB

Common Peripheral Devices

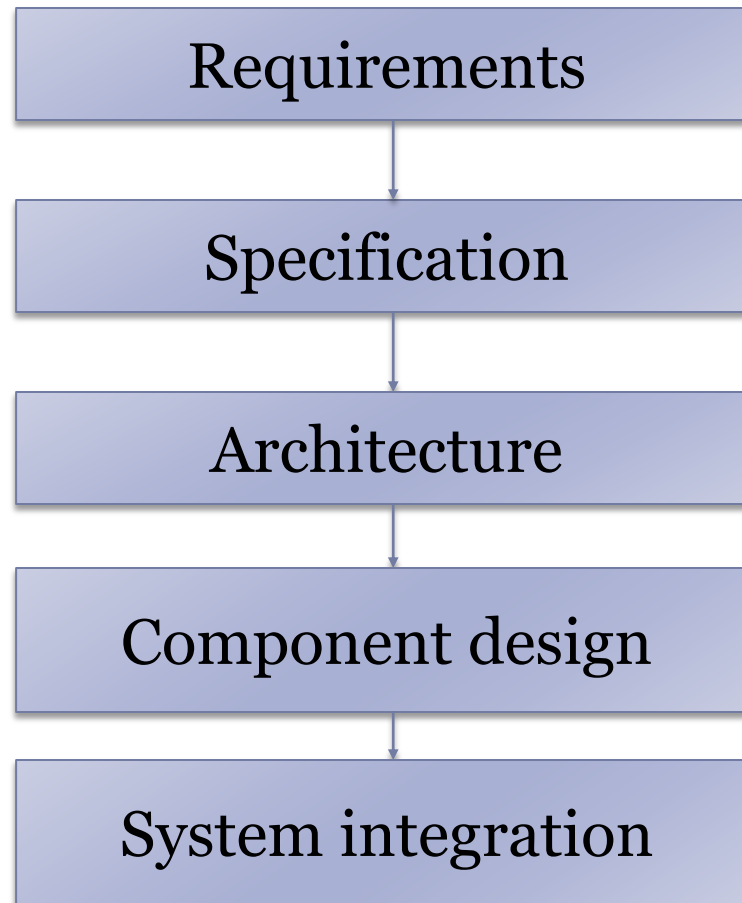
- Interrupt controller
- DMA controller
- Timer/Counter
- Real-time clock
- Watchdog timer
- UART (Universal Asynchronous Receiver Transmitter)
- IrDA (Infrared)
- Ethernet (wired/wireless)
- Bluetooth

Recent Trends

- Increasing computation demands
- Increasingly networked
- Increasing need for flexibility

- Getting complex
- Increasingly platform-based
 - Hardware architecture + associated software

Design Process



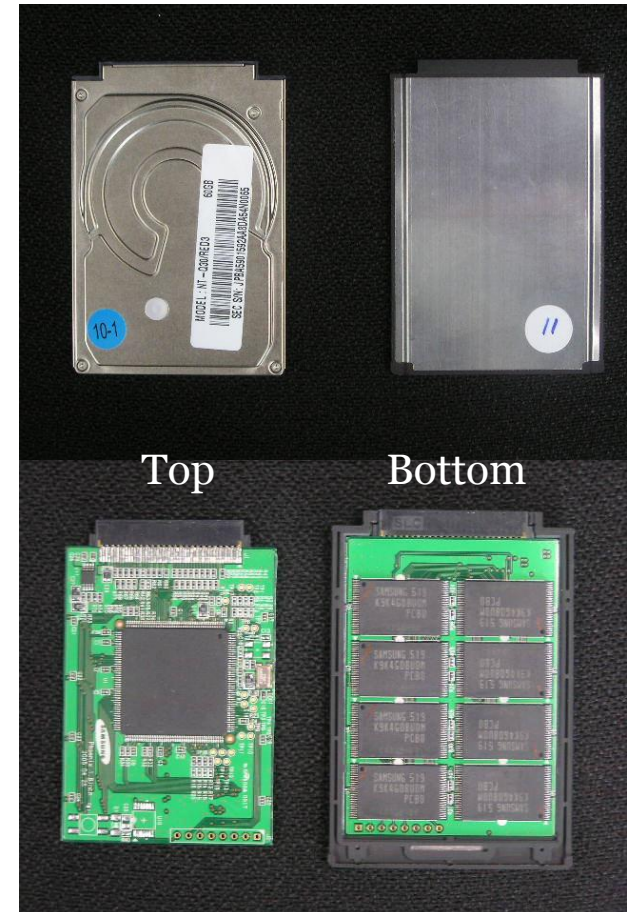
Solid State Drives (SSDs)

HDDs vs. SSDs (1)

2.5" HDD Flash SSD
(101x70x9.3mm)



1.8" HDD Flash SSD
(78.5x54x4.15mm)



HDDs vs. SSDs (2)

Feature	SSD (Samsung)	HDD (Seagate)
Model	MMDOE56G5MXP (PM800)	ST9500420AS (Momentus 7200.4)
Capacity	256GB (16Gb MLC x 128, 8 channels)	500GB (2 Discs, 4 Heads, 7200RPM)
Form factor	2.5" Weight: 84g	2.5" Weight: 110g
Host interface	Serial ATA-2 (3.0 Gbps) Host transfer rate: 300MB	Serial ATA-2 (3.0 Gbps) Host transfer rate: 300MB
Power consumption	Active: 0.26W Idle/Standby/Sleep: 0.15W	Active: 2.1W (Read), 2.2W (Write) Idle: 0.69W, Standby/Sleep: 0.2W
Performance	Sequential read: Up to 220 MB/s Sequential write: Up to 185 MB/s	Power-on to ready: 4.5 sec Average latency: 4.17 msec
Measured performance ¹ (On MacBook Pro, 256KB for sequential, 4KB for random)	Sequential read: 176.73 MB/s Sequential write: 159.98 MB/s Random read: 10.56 MB/s Random write: 2.93 MB/s	Sequential read: 86.07 MB/s Sequential write: 84.64 MB/s Random read: 0.61 MB/s Random write: 1.28 MB/s
Price ²	539,190 won	80,400 won

¹ Source: <http://forums.macrumors.com/showthread.php?t=658571> ² Source: <http://www.danawa.com> (As of Mar. 17, 2011)

1\$-per-GB?

OCZ Technology
“신제품 출시기념 통큰 특가 기획전”

OCTANE S2
2.5 SOLID STATE DRIVE

SATA 2 (3.0Gbps)
읽기 : 최대 275MB/s
쓰기 : 최대 135MB/s

인디링크 EVEREST 컨트롤러
25nm MLC낸드플래시
최대 512MB의 캐시버퍼
TRIM, GC 가능

랜덤 4K 읽기 : 최대 29,000 IOPS
랜덤 4K 쓰기 : 최대 9000 IOPS

128GB

the SSD experts!



OCZ Instant ON

판매가 : 168,000원
특가 : 149,800원 바로 구입하기

INDILINK
INFUSED

OCZ Instant ON

인스턴트 온 기술로 부팅을 더욱 빠르게 합니다.

TRIM Support

SSD는 낸드로 구성되어 있어, 하드디스크와 달리 기존에 삭제된 데이터가 완전히 삭제되지 않고 남아 있게됩니다. 이를 완전히 삭제하여 다음 기록시에 원활하게 동작하도록 하여 프리징 현을 개선하도록 합니다.

GC Garbage Collection

쓰레기를 수집한다는 의미의 이 기술은, 사용이 계속되면서 발생하는 불필요한 영역을 자동으로 해제하여 사용가능 공간으로 만들어 성능을 향상시키는 기술입니다.

WEAR LEVELING

낸드를 다루는 해당 쓰기 수량이 있습니다. 특정 블록에 과도하게 집적하게 되면 SSD의 수명은 급격히 감소하게 됩니다. 워칭 레벨링 과다 쓰기를 줄이고, 균등쓰기를 통해 SSD의 수명을 연장합니다.

AES 128/256 데이터 암호화 기술

데이터의 보안이 중요해진 지금, AES는 DES를 대신할 차세대 표준 알고리즘입니다. 데이터에 암호를 걸어, 외부에서의 침입이나 해킹시에 중요한 정보 유출을 방지합니다.

nDurance

낸드를 다루는 해당 쓰기횟수가 한정되어 있어, 이를 늘리는 기술이 개발되어 왔습니다. OCZ의 nDurance는 해당 기록할 수 있는 횟수를 늘려주어 제품의 수명을 향상시켜 줍니다.

Source: http://www.gamemeca.com/hardware/news_view.html?seq=2109009&yymd=20120227 (Feb. 27, 2012)

Outlook



News



SSD Per-GB Cost to Fall Below \$1 in Second Half of 2012 - Market Observers.

SSDs to Gain Considerable Market Share This Year, Says DRAMeXchange

[03/07/2012 08:53 PM]
by [Anton Shilov](#)

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COMMENTS (1)

The \$1-per-GB price has been for a long time considered as a holy grail for solid-state drives as it is widely believed that at such price points SSDs will start to be adopted by mainstream users.

According to DRAMeXchange, a division of TrendForce market research firm, the price per GB will be even lower than \$1 in the second half of the year, which will unleash growth potential for SSDs.

After SSDs based on NAND flash memory manufactured using the latest - 19nm, 20nm and similar - process technologies enter mass production in the second half of 2012, unit cost may fall below \$1-per-GB, the pricing sweet spot the market has been anticipating. When this occurs, DRAMeXchange expects ultrabook/thin notebook makers will transition from adopting hybrid HDD solutions to pure SSD solutions, and mainstream capacity will increase to 128GB.

Source: http://www.xbitlabs.com/news/storage/display/20120307205305_SSD_Per_GB_Cost_to_Fall_Below_1_in_Second_Half_of_2012_Market_Observers.html

SSD Internals

