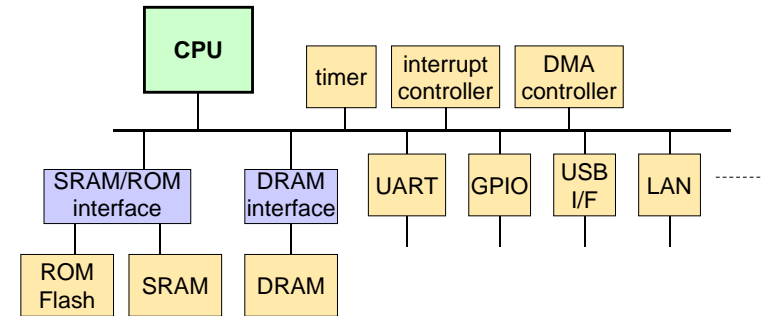
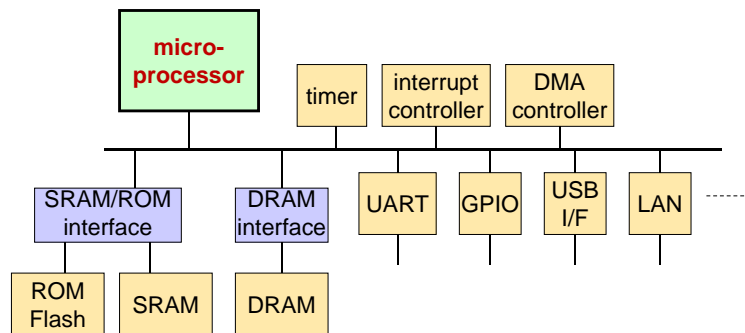


## 2. 임베디드시스템 하드웨어/프로세서

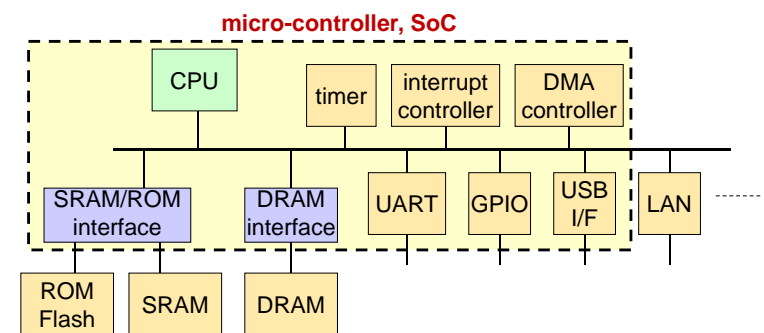
## 임베디드 시스템 하드웨어 구조



## - 마이크로프로세서를 사용한 시스템



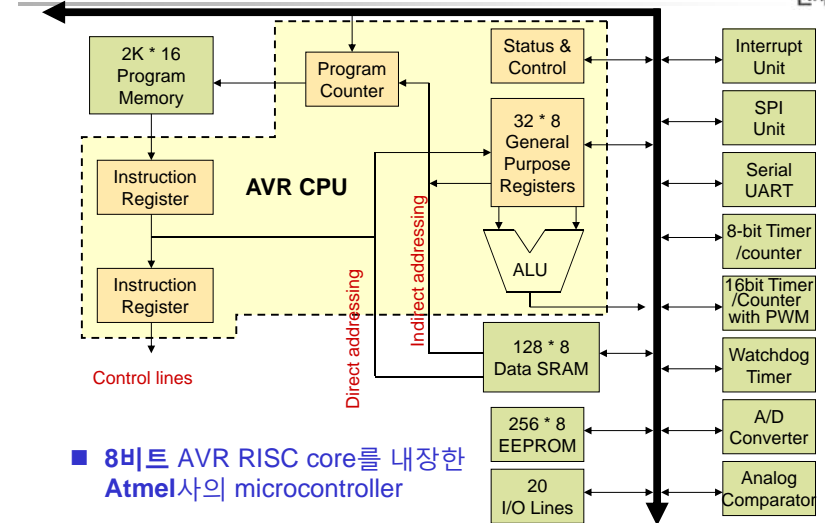
## - 마이크로컨트롤러를 사용한 시스템



# 임베디드 프로세서

- AVR
- 인텔 8051
- 인텔 386
- ARM7, ARM9, ARM Cortex A7/A8/A9, Xscale
- AE3200
- MIPS
- PPC (PowerPC)
- S390

# AVR



- 8비트 AVR RISC core를 내장한 Atmel사의 microcontroller

# - AVR의 종류

- 내장된 메모리와 외부 접속장치 규모에 따라 분류
  - tiny AVR (ATtiny..)
    - 512B ~16KB program memory, 6~32 pin, 제한된 입출력제어기
    - (용도) 메인 마이컴보다 여러 회로를 하나로 구현한 보조 역할의 칩
  - mega AVR (ATmega..)
    - 4~512KB program memory, 28~100 pin,
    - 추가된 입출력제어기
    - 확장 명령어집합
    - (용도) 대형이고 입/출력 핀이 많은 시스템. 무선전화기, 프린터용 제어기, FAX, CD-ROM 제어기, 통신 장비
  - XMEGA (ATxmega..)
    - 16~384KB program memory, 32/44/64/100 pin,
    - 저전력, 고성능, 풍부한 peripherals (DMA, USB, LCD제어기, Crypto엔진 등), advanced ADCs
  - AVR32 : 32비트 AVR UC3 마이크로컨트롤러 (AT32UC3..)



# - Arduino

- 오픈 소스기반의 AVR기반 마이크로컨트롤러 보드
- 2005년에 Italy의 Interaction Design Institute Ivrea에서 학생들의 교육을 위한 프로젝트로 시작
  - Arduino 프로그램(스케치)은 C/C++ 언어로 작성
  - Arduino 제어와 입출력 장치 제어를 위한 library들이 제공됨
  - 많은 수의 간단한 입출력 장치들을 입수 가능

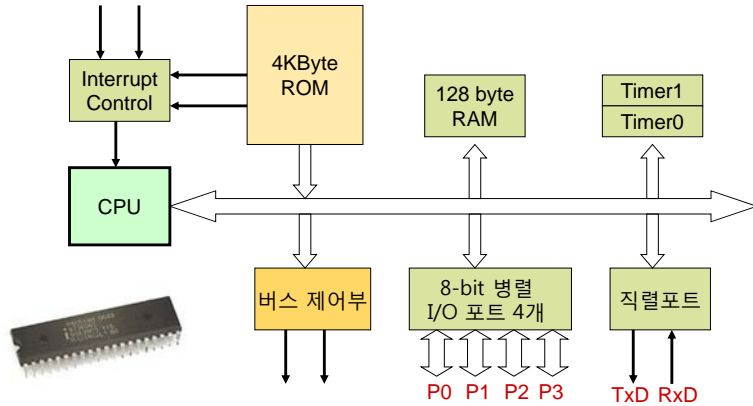


Arduino USB – ATmega328P 사용

Arduino Mega – ATmega2560 사용

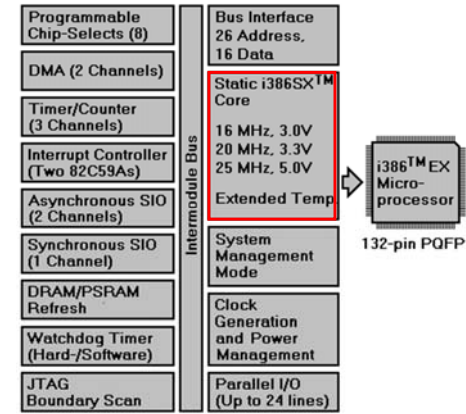
# 8051 마이크로컨트롤러

- 1980대 초부터 현재까지 사용되고 있는 Intel사의 8비트 microcontroller
  - 모뎀, 타자기, 게임기 등에 광범위하게 사용됨
  - 현재도 Atmel, Maxim, NXP, TI, Cypress 등 많은 회사에서 호환제품 출시



# 80386EX Embedded Microprocessor

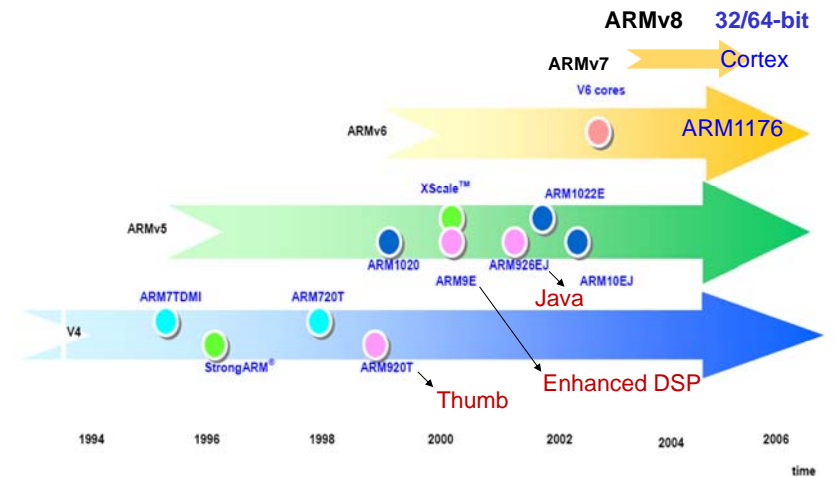
- Intel 80386SX core를 내장 – large software 기반



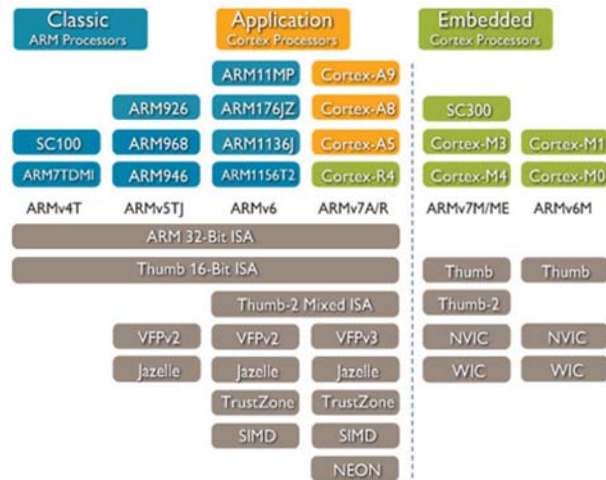
# ARM

- 영국 ARM (Advanced RISC Machine)사에서 설계한 RISC CPU core
- 반도체 회사/SoC 제조사에서 주변장치를 추가하여 SoC형태로 판매
  - Apple, Atmel, Broadcom, Cypress, Freescale, Nvidia, NXP, Qualcomm, Samsung, ST Microelectronics, Texas Instruments
- 32bit RISC Architecture
- 간단하고도 강력한 명령어 지원
  - 32bit ARM 명령과 16bit Thumb 명령을 제공
  - Jazelle core를 확장한 경우 8bit Java byte 코드도 실행가능
- 저전력 소모
- Fast interrupt 지원
  - 빠른 인터럽트 처리를 위해 별도의 fast 인터럽트 방식 제공
  - fast 인터럽트를 위한 별도의 레지스터를 가지고 있어 서비스 루틴 (Interrupt Service Routine)을 작성할 때 레지스터를 저장하고 복구하는 시간을 줄일 수 있다

# ARM Architecture의 종류



## ARM Architecture의 종류 (2)



## Cortex Application Processors

- Cortex Application Processors (Cortex-A..)
  - 복잡한 운영체제를 수행시킬 수 있는 성능 제공, MMU 내장
    - Linux, Android/Chrome, Windows CE/Embedded 등
  - **single-core** 또는 **multi-core** 내장
  - optional **NEON™ multimedia processing blocks** and advanced **Floating Point execution units**.
- Applications
  - Smartphone
  - Smartbook & Netbooks
  - eBook Readers
  - Digital TV
  - Set-top Box & Satellite Receiver
  - Home Gateways
  - High-End Printers 등

## Cortex Embedded Processors

- Cortex-M series processors (Cortex-M..) - **embedded**
  - have been developed primarily for the microcontroller domain where the need for **fast, highly deterministic, interrupt management** is coupled with the desire for **extremely low gate count** and **lowest possible power consumption**.
  - Applications:
    - Microcontrollers, Mixed signal devices, Smart sensors, Automotive body electronics and airbags
- Cortex-R series processors (Cortex-R..) – **real-time**
  - however have been developed for **deeply embedded real-time applications** where the need for **low power** and **good interrupt behaviour** are **balanced** with exceptional performance and strong compatibility with existing platforms.
  - Applications:
    - Automotive braking systems, Powertrain solutions, Mass storage controller, Networking & Printing

## ARM-based processor – Samsung S3C6410

ARM1176

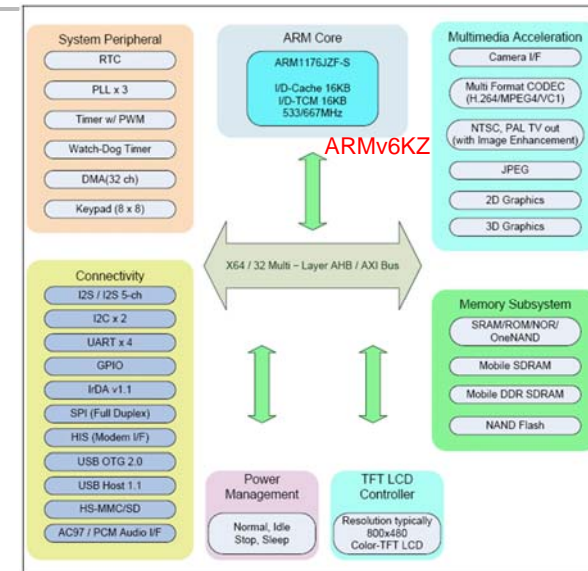
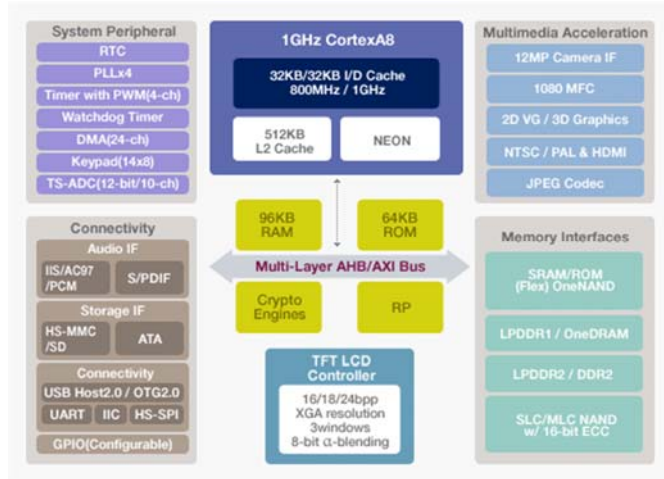


Figure 1-1 S3C6410X Block Diagram

## - Samsung S5C110

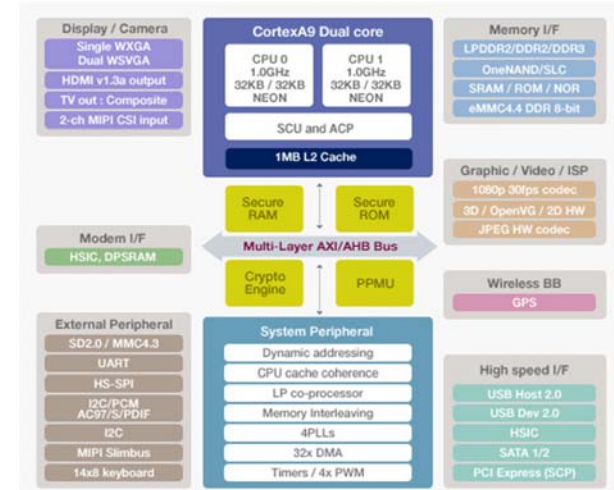
### ■ ARM Cortex A8 based Mobile Application Processor



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## - Samsung Exynos 4210

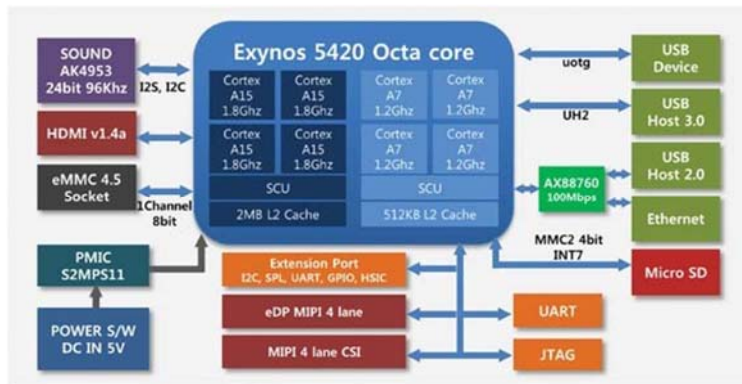
### ■ ARM Cortex A9 (dual core)



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## - Samsung Exynos 5420

### ■ ARM Cortex A15 (quad core) + ARM Cortex A7 (quad core)

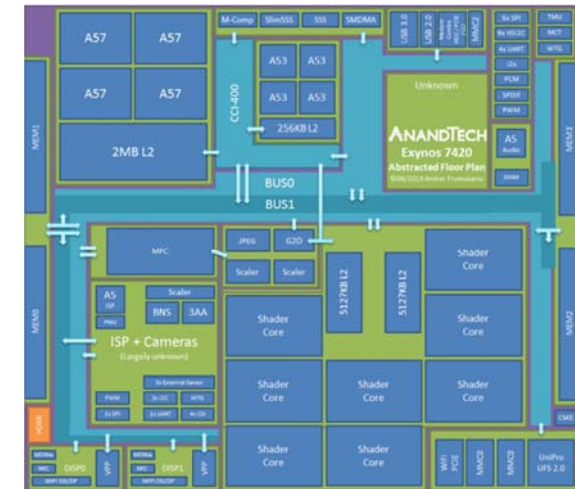


Galaxy S5

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## - Samsung Exynos 7420

### ■ 64-bit ARM Cortex A57 (quad) + ARM Cortex A53 (quad)



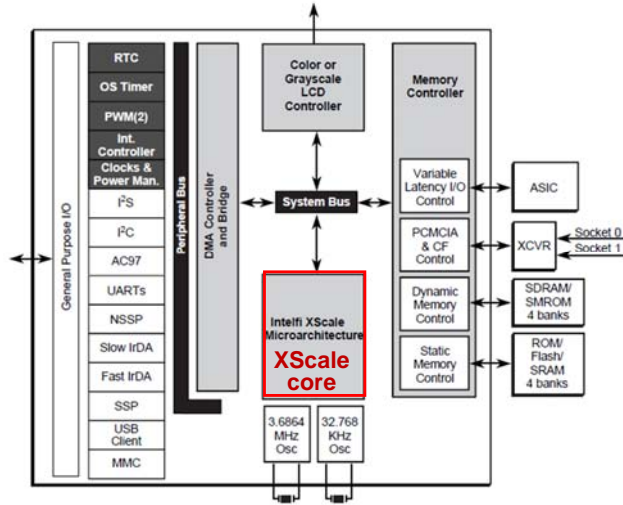
Galaxy S6

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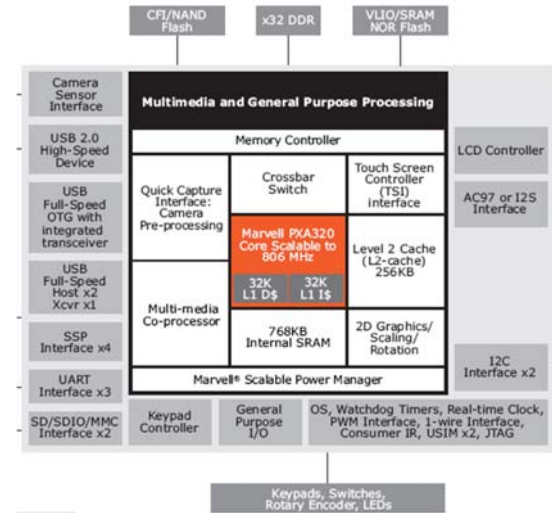


# ARM-based processor – Intel PXA255

- Now Marvell
- PXA255
- PXA270
- PXA300/310
- PXA320



# ARM-based processor – Marvell PXA320



# – Marvell ARMADA610

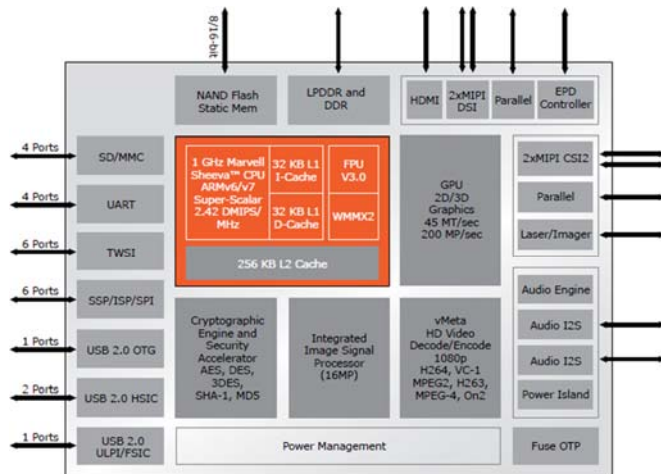


Fig 1. Marvell ARMADA 610 Application Processor

# Qualcomm Snapdragon

Krait – Snapdragon에서 사용하는 ARM-based CPU  
Cortex-A15와 유사한 구조 (ARMv7-A instruction set)

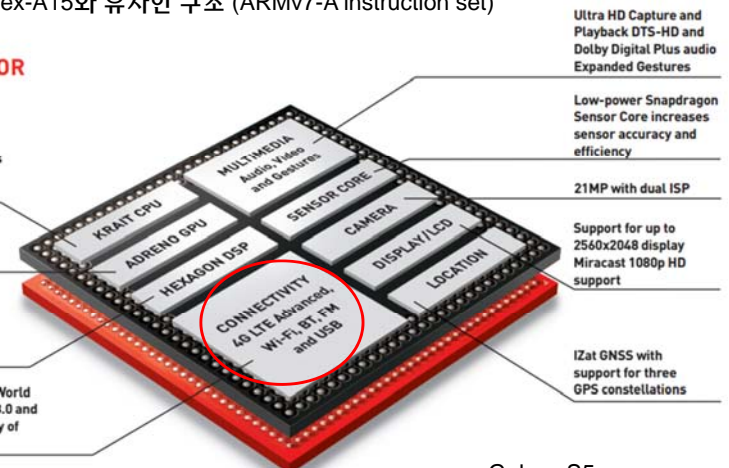
## 800 PROCESSOR

Krait 400 CPU features 28HPm process technology superior 20Hz+ performance

Adreno 330 for advanced graphics

Hexagon QDSP6 for ultra low power applications and custom programmability

Integrated Gobi 4G LTE World Mode<sup>1</sup>, 802.11ac<sup>1</sup>, USB 3.0 and BT 4.0 offers broad array of high speed connectivity



Ultra HD Capture and Playback DTS-HD and Dolby Digital Plus audio Expanded Gestures

Low-power Snapdragon Sensor Core increases sensor accuracy and efficiency

21MP with dual ISP

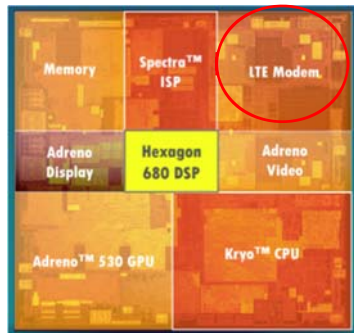
Support for up to 2560x2048 display Miracast 1080p HD support

IzAT GNSS with support for three GPS constellations

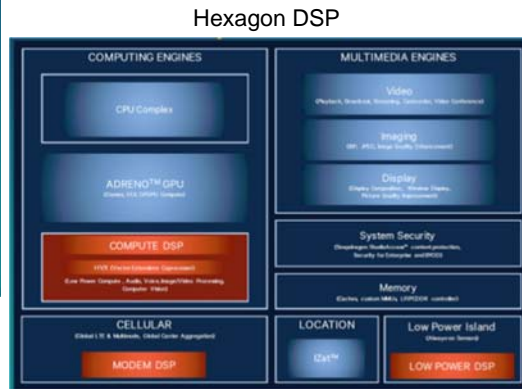
Galaxy S5

## - Snapdragon 820

- Kryo CPU – 64-bit ARMv8-A instruction set
  - ARM Cortex-A53과 유사한 구조



Galaxy S7



## ARM기반 소형 보드 – BeagleBone

### ■ Beagle Board



- TI OMAP3530 사용 (ARM Cortex-A8, TI DSP core 내장)
- 리눅스 지원

### Beaglebone Black



- TI AM3358 Sitara processor (ARM Cortex-A8)

## ARM기반 소형 보드 : Raspberry Pi

### ■ Raspberry Pi

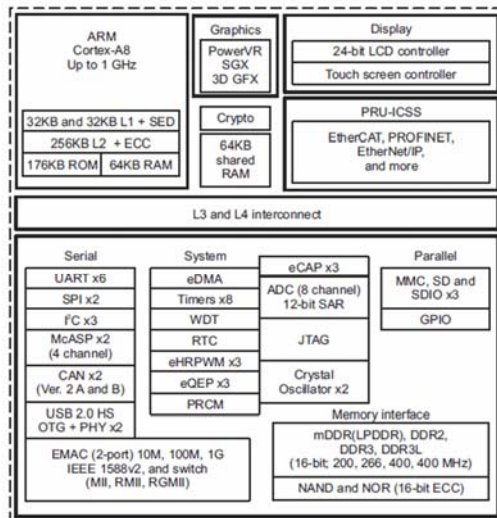


- Broadcom BCM2835 사용 (ARM1176JZ-F, VideoCoreIV multimedia프로세서 내장)
- 리눅스 지원, Python 언어

### Raspberry Pi 2 / Raspberry Pi 3



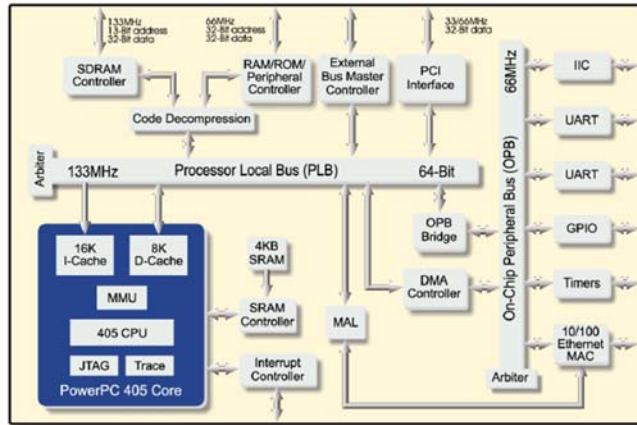
- Broadcom BCM2836 (Cortex A7) / BCM2837 (Cortex A8, 64-bit) 사용



TI AM335x

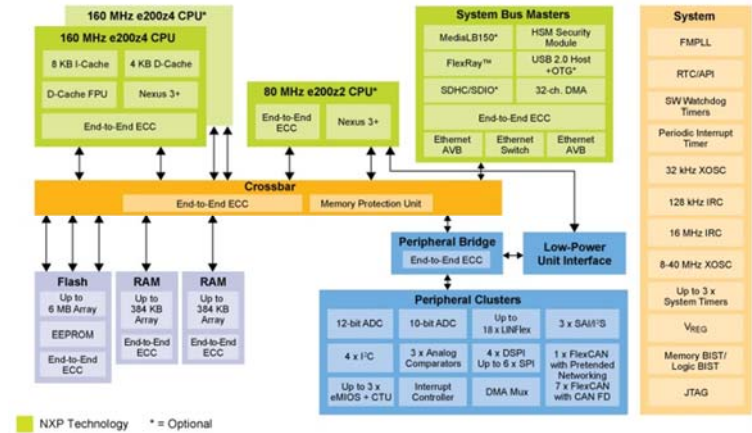
# PowerPC 계열 프로세서

- PowerPC: IBM, Apple, Motorola(현재 Freescale) 3사가 공동 개발
- (예) AMCC(AppliedMicro)사의 PPC405GP embedded processor



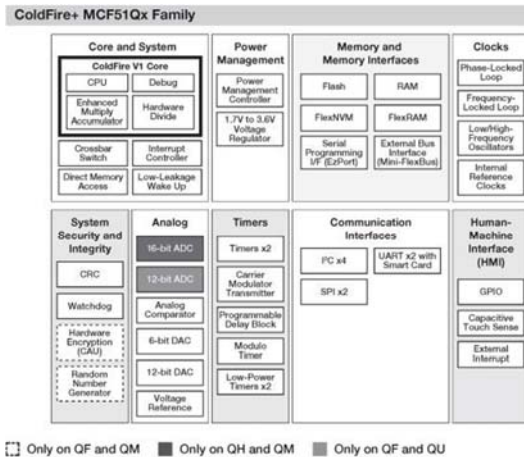
# - NXP freescale MPC5748

- Automotive & Industrial Control and gateway용 powerPC MCU
  - NXP(네덜란드 회사) – 2015년 freescale을 인수



# Freescale(now NXP) ColdFire/68K

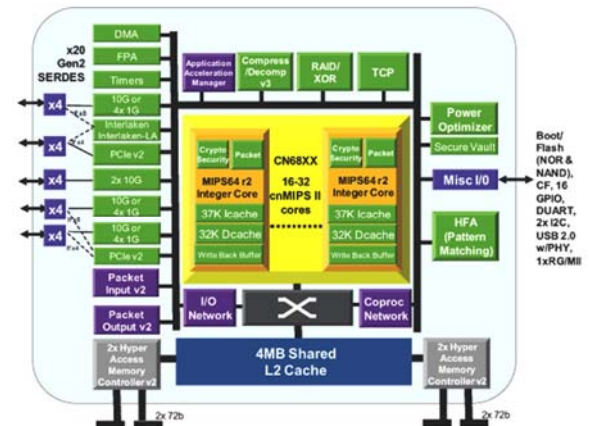
- ColdFire - Motorola 680x0 프로세서 구조를 Freescale사에서 embedded 시스템용으로 개선한 프로세서, 68K와 assembly source compatible



Freescale MCF51Qx

# MIPS 계열 프로세서

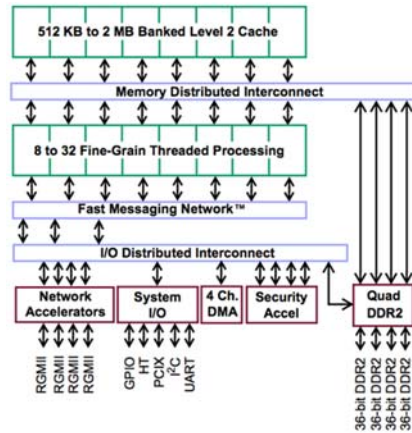
- Cisco 라우터, Sony Playstation 등에 사용됨
- (예) Cavium Network사의 OCTEON II CN68XX





## MIPS 계열 프로세서(2)

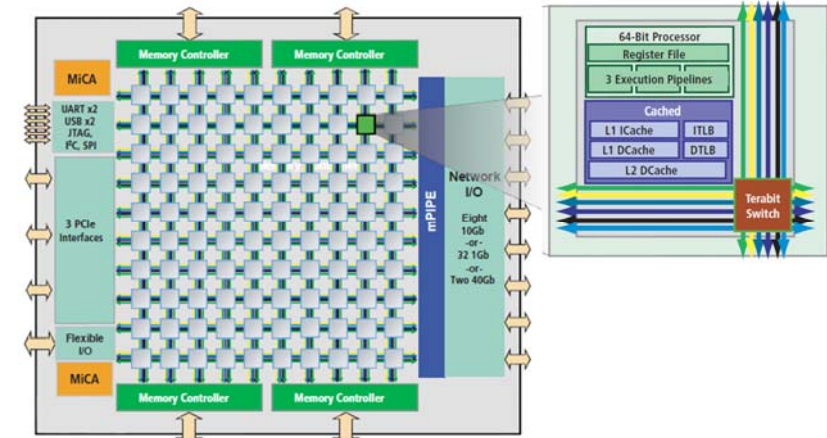
- NetLogic사의 XLR500 scalable communication processor
  - MIPS64기반, 최대 8 MIPS core, 각 core는 4-way multi-threaded



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## Tilera

- 16-100개의 VLIW processor cores(tiles)를 iMesh on-chip network으로 연결한 고성능 임베디드 프로세서



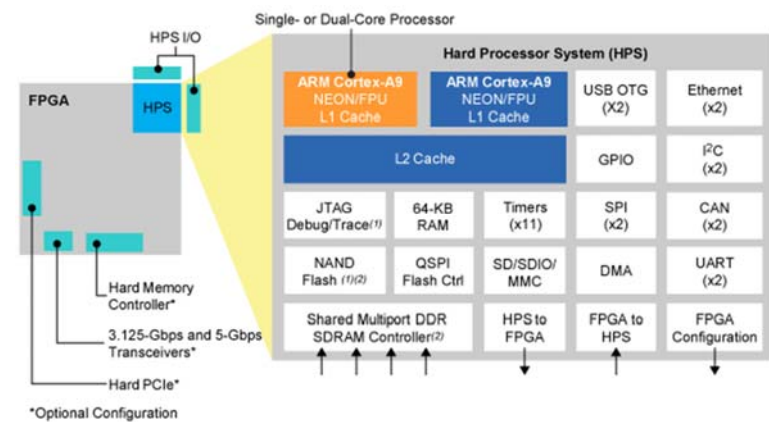
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## Processor core 내장 FPGA

- Altera Excilibur
  - ARM922T core 내장 FPGA
- Xilinx Virtex 4
  - PowerPC405 core 내장 FPGA
- Xilinx Microblaze
  - Xilinx사의 FPGA에 내장될 수 있는 softcore processor
- Altera NIOS-II
  - Altera사의 FPGA에 내장될 수 있는 configurable processor
- Altera Cyclone V SoC, Arria 10 SoC
  - dual-core ARM cortex-A9 MPCore 내장 FPGA
- Xilinx Zynq-7000 SoC
  - dual-core ARM Cortex-A9 Processor 내장 FPGA

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## Cyclone V – ARM based SoC



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