Embedded System

1. Introduction

CONTENTS

1. Embedded System

- “Embedded”

- Embedded System ➔ Electronic Control System containing Computer Hardware & Software

- Contemporary ES → Special Computer Unit with Microprocessor or Microcontroller for achieving special purposes

- PC → General purpose, Not an ES !

- A computer system with special purposes → ES → Various Applications

1. Embedded System

- Example of ES

2. Real Time system

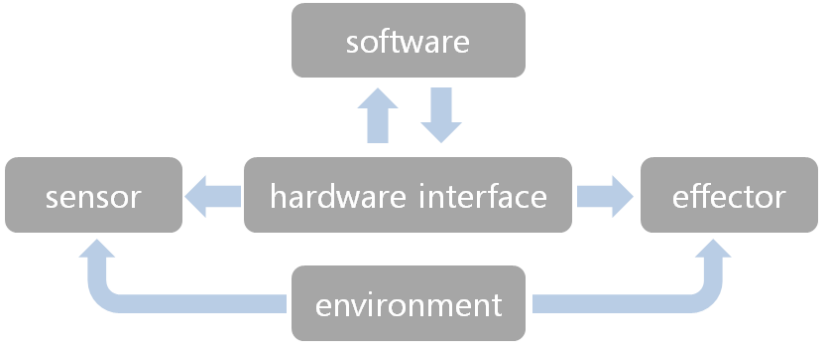
- In general, ES responses or treating with user's input or environments' changes

- General ES → Exact Operation of Logically Defined Functions with the predefined sequences

- RT system → ES + "on-time / in-time"

- RT system

  : The time of (Data Sensing + CPU handling + Actuator Handling) < the due date



3. Embedded OS

- Early ES → Designed only for achieving special objectives → The existence of OS was too much

- Recent ES → Network / Multimedia → Complex architectures → OS is needed!

- Recent ES = RT → RTOS is introduced into ES

- Current → ES' OS = RTOS

3. Embedded OS

Embedded OS → RTOS (Real Time OS)/ GPOS (General Purpose OS)

RTOS(Real Time OS)

- Generate output within the due date
- Not a fast processing, but JIT handling
- General RTOS considers
  : response speed, interrupt), Efficiency, Scalability, Portability

GPOS(General Purpose OS)

- GPOS = Windows NT, Windows 7/8/10, DOS, Linux, UNIX, Macintosh OS
- Needed Large Memory & ROM
- MMU (Memory Management Unit) is needed for handling Local File System, Paged Virtual Memory

4. Embedded System Application

- Market of ES > Market of General PC

Category	Contents
Car	Smart Car, Car Integrated Control System, Car-to-Car Communication
Vessel	Intelligent Vessel, e-navigation , Wireless Communication
Military	NX military communication, Air force S/W, Drone Network
Architect	U-city, EMP, Home network
Medical System	Surgery Robot, U-Health

4. Embedded System Application

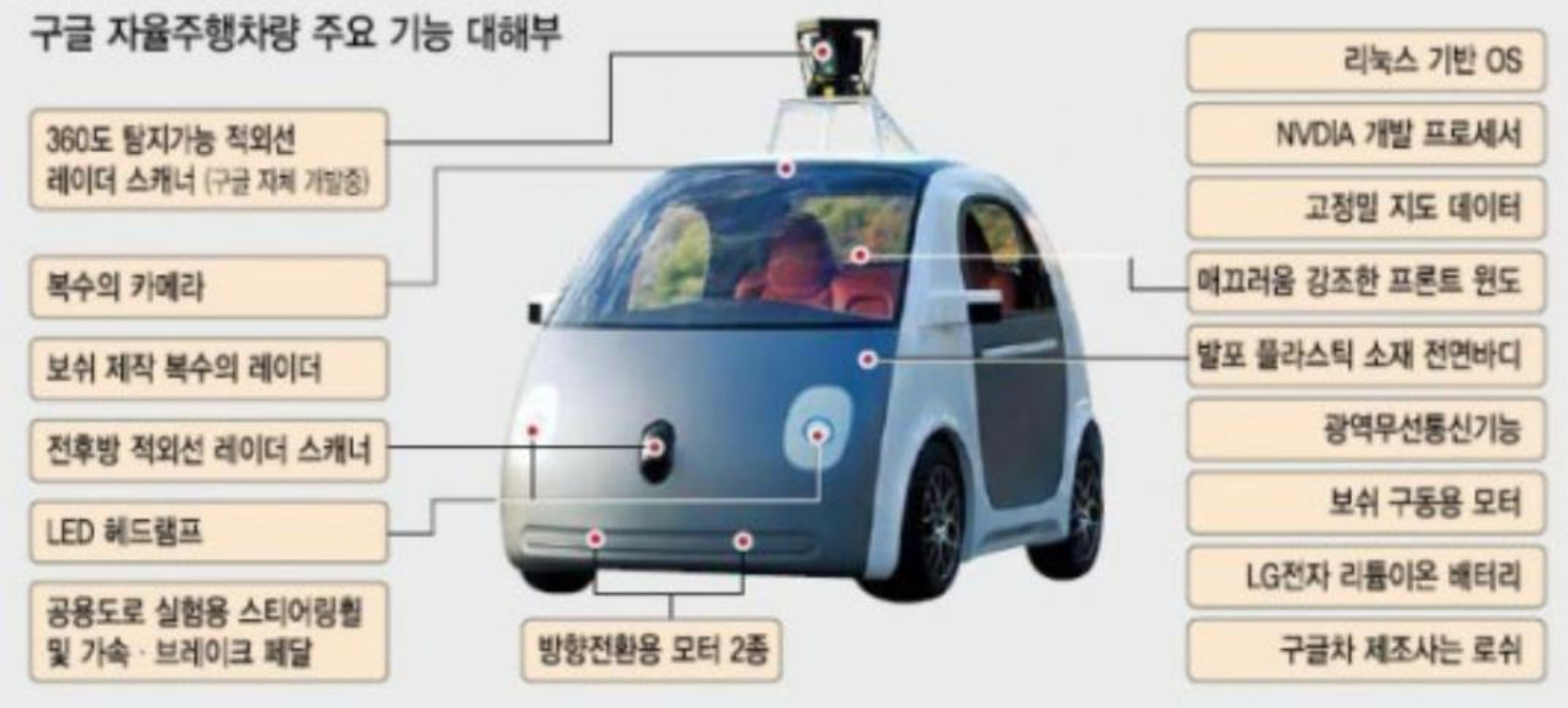
Information Terminal

- PDA, Mobile phone, Tablet
- RTOS → GPOS

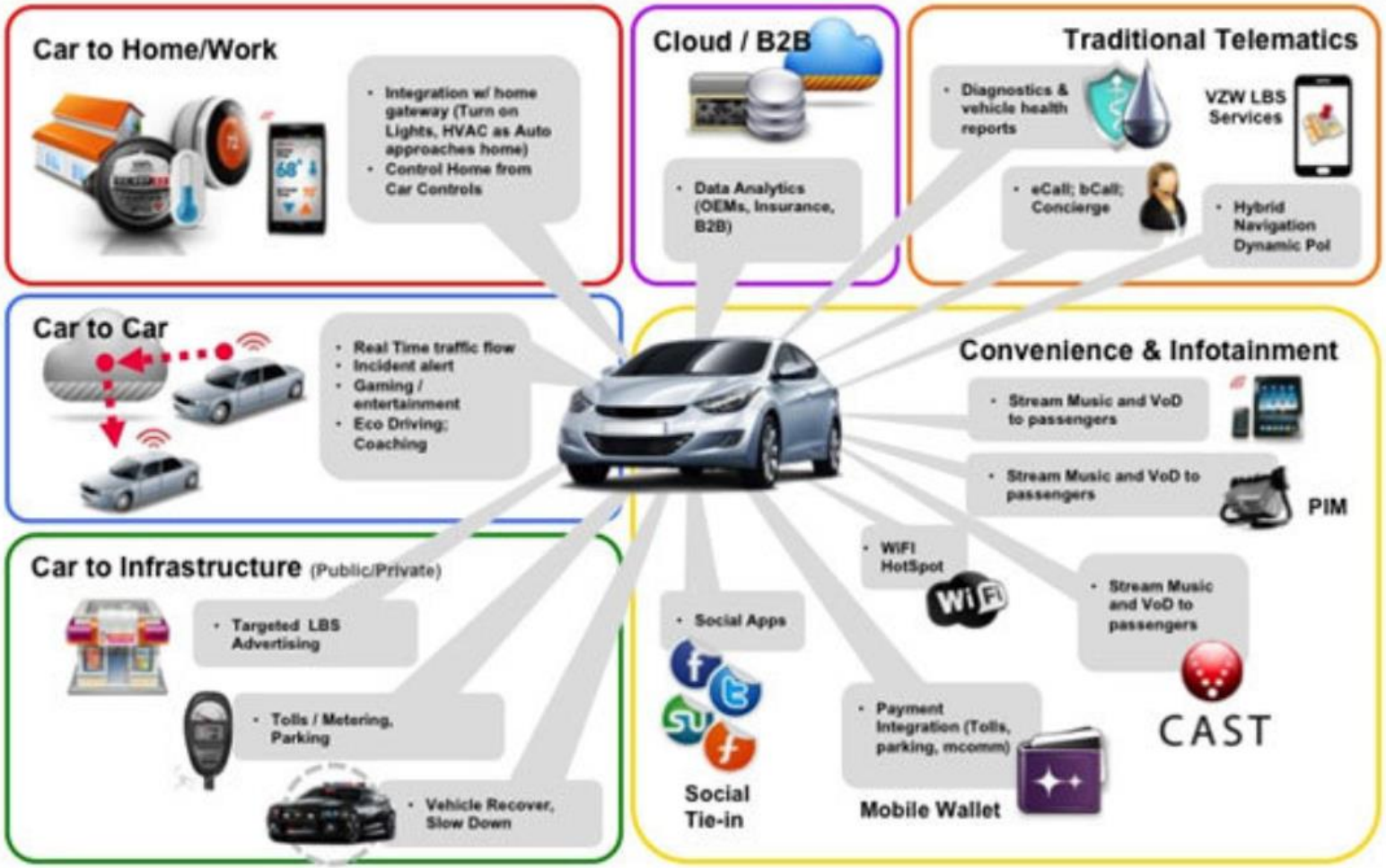
Traffic and Vehicle

- Car + ICT Convergence
- LBS

4. Embedded System Application



4. Embedded System Application



4. Embedded System Application

https://en.wikipedia.org/wiki/Google_driverless_car

Did you know Google's self-driving cars can't handle 99% of roads in the US?

Credit: Google

Many people have heard that Google's autonomous cars can “drive anywhere a car can legally drive,” but it can't drive in snow, heavy rains, see "unmapped" traffic lights or stop signs. In other words, Google's self-driving cars can handle the "matrix" but it can't navigate on 99% of the roads in the U.S.

4. Embedded System Application

SCM and Finance

- POS, RF TAG, ATM , ID Card

Information Entertainment / Appliance

- Smart TV → TV + OS → Internet, Game, POS, SNS + TV

4. Embedded System Application

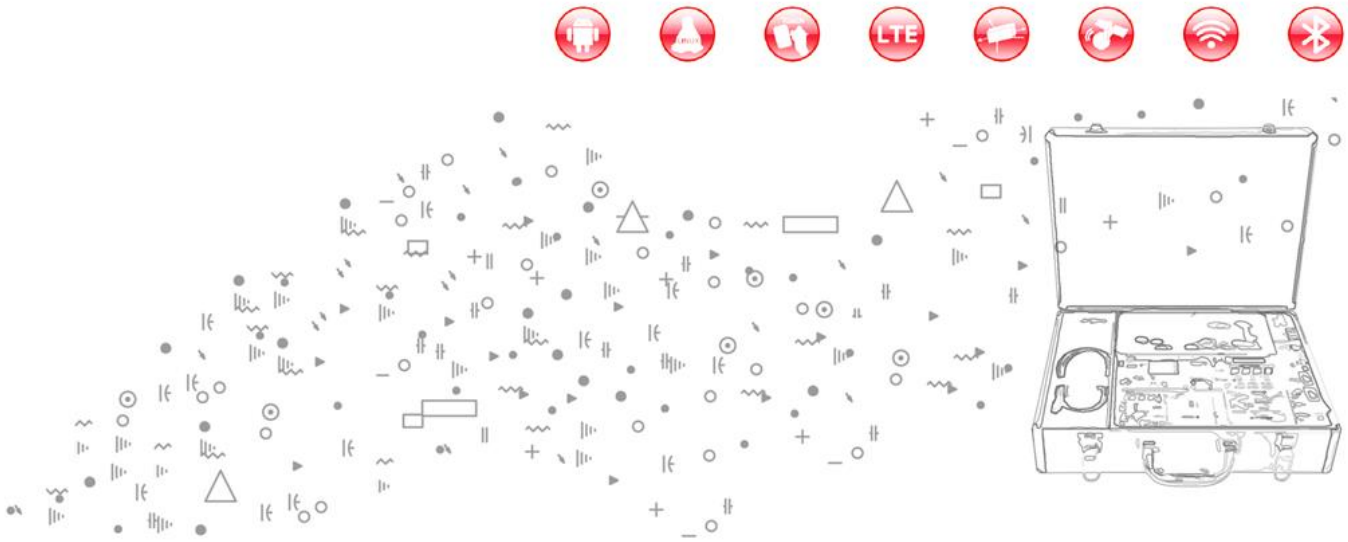
Industry and Control

- FA(Factory Automation) & PLC(Programmable Logic Controller)

Medical Application

- Virtual Solution, U-health

2. Embedded Processor



5. Processor

- The first ES development → What is the processor of ES ?
- Processor → CPU
- When the CPU is fixed, OS is selected. Then, ES is builted
- General Classification of Processor → With "Data bus Size" → 8, 16, 32, 64, 128 bit

CISC, RISC type Processors (Intel Vs. ARM)

6. CISC Vs. RISC

Classification	CISC	RISC
CPU instruction	Many Commands Various Length Many execution cycle	Fixed Length Size of Word = Size of Data bus The same execution cycle
Circuit	Complex	Simple
Memory Usage	Highly efficient	Low efficiency
Program	Short	Long
Compiler	Complicated	Comparatively Simple
Manufacturer	Intel, AMD, Atmel	SAMSUNG, TI, Atmel, ST

CISC- Complex Instruction Set Computer
RISC – Reduced Instruction Set Computer

7. ARM RISC

- ARM(Advanced RISC Machine) →RISC-based 32bit embedded processor

RISC

- load-store architecture
- fixed 32bit command
- address type

ARM RISC 기능

- 16 bit command is allowed
- Conditional command architecture
- optimal number of registers

Barrel Shift Register

- Barrel Shift is installed on ALU input layer→ Easy shift → Fast Execution
- Less Memory Usage, Cheaper, Low energy consumption

8. Application Processor (AP)

Application Processor

- Mobile Device's processor

- Smart phone → Communication is important → Modem's processor (Subsidiary Processor) is important → It substitute the existing main processor → Application-specific processor → Application Processor

- AP ➔ two trends → 1) Multimedia driven AP or 2) Performance/Speed driven AP

- Current Trends → Performance / Speed driven AP

- General Smart Phone AP → ARM architecture

- ARM 7/9/11 → Cortex

- 2013 → Cortex A9 architecture

- AP + Memory + Controller → one Chip → System on Chip → SoC

- 2015, 10 → Cortex architecture A57→ ARM v8-A

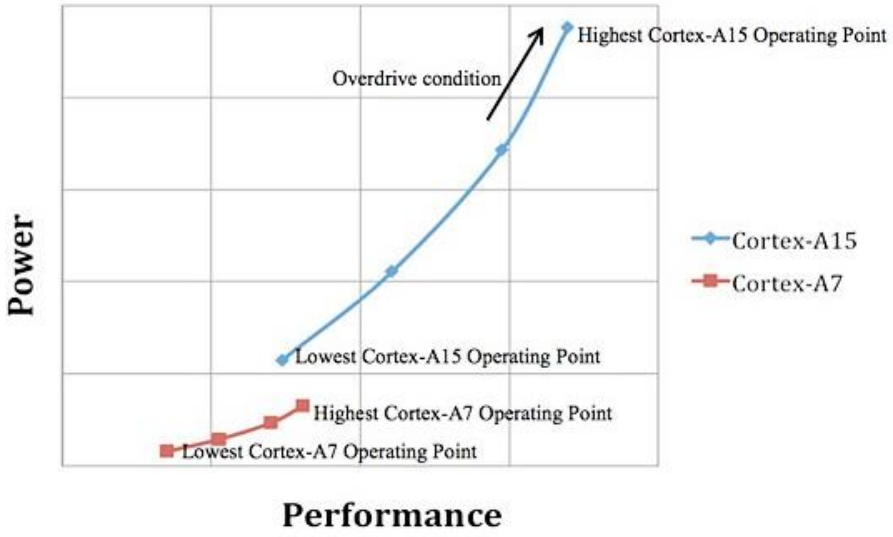
8. Application Processor (AP)

ARM Trends

- High resolution display, Powerful Multimedia, Low Energy Consumption

- Big Little Architecture

  "High Speed Core Set" + "Low Energy Core Set"



Highlights

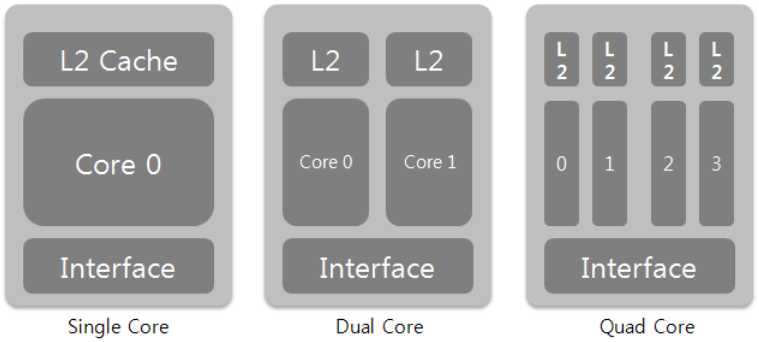
- 4X ARM Cortex A15 cores at 1.8GHz
- 4X ARM Cortez A7 cores at 1.2GHz
- 28nm Samsung manufacturing process
- Graphics: PowerVR SGX-544MP3 at 533MHz

- The first Big Little Architecture AP → Exynos5 Octa

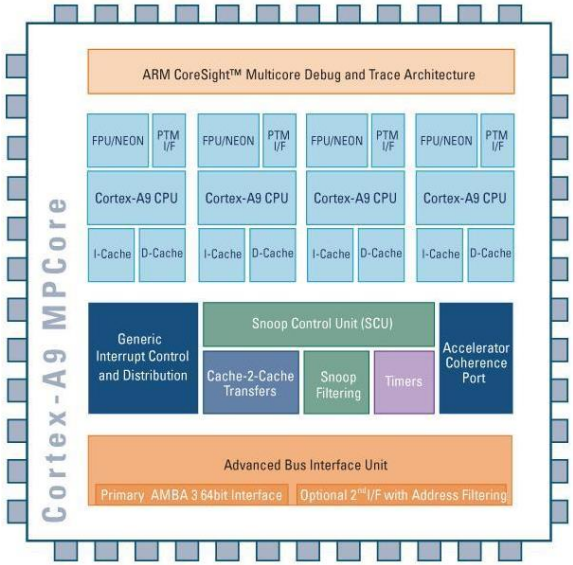
9. Multicore Processor

- Current AP Trends → Multi cores

- Performance level up per a core < Multi core with common abilities cores



- Cortex MpCore



Appendix

A. ARM Cortex-A9

Type	Architecture Ver.	Core	Function	Cache
ARM11	ARMv6	ARM1136J(F)-S	SIMD, Jazelle DBX, (VFP) 8-stage Pipeline	variable, MMU
	ARMv6T2	ARM1156T2(F)-S	SIMD, Thumb-2, (VFP) 9-stage Pipeline	variable, MPU
	ARMv6KZ	ARM1176JZ(F)-S	SIMD, Jazelle DBX, (VFP)	variable MMU+TrustZone
	ARMv6K	ARM11 MPCore	1-4 core SMP, SIMD Jazelle DBX, (VFP)	variable, MMU

B. ARM Cortex-A9

Type	Architecture Ver.	Core	Function	Cache
Cortex	ARMv7-A	Cortex-A8	Application profile, VFP, NEON, Jazelle RCT, Thumb-2, 13-stage, perscalar pipeline	variable (L1+L2), MMU +TrustZone
		Cortex-A9	Application profile, (VFP), (NEON) Jazelle RCT and DBX, Thumb-2 Out-of-order speculative issue superscalar	MMU+TrustZone
		Cortex-A9 MPCore	**As Cortex-A9, 1-4 코어 SMP**	**MMU+TrustZone**
	ARMv7-R	Cortex-R4(F)	Embedded profile, (FPU)	variable Cache MPU optional
	ARMv7-M	Cortex-M3	Microcontroller profile, Thumb-2 only.	Cache, (MPU)
	ARMv6-M	Cortex-M1	FPGA targeted, Micro controller profile	tightly coupled memory optional.