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CREST (Center for Realtime Embedded System Technology)
<http://realtime.ssu.ac.kr>

Computing the Future!

2017. 11.

송실대학교 IT대학
컴퓨터 학부
양승민 교수

Computing the Future?

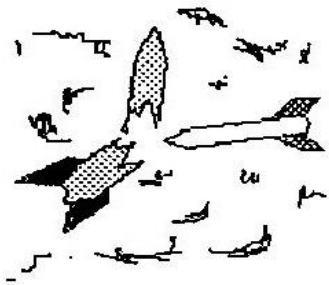
→ Back to the Basic!

Once upon a time,
There were...

- CDC 6600 (1973)
- Zilog Z80 Microprocessor (1978)
- BMD (Ballistic Missile Defense) (1981)

1978-2017 Seung Min Yang

- Samsung Co., Software Engineer (1978.2-1981.7)
- Univ. of South Florida, MS and PhD (1981.9-1987.8)
- Univ. of South Florida, Professor (1986.9-1987-8)
- Univ. of Texas at Arlington, Professor (1987.8-1993.1)
- **Soongsil Univ., Professor (1993.1-2017.8)**
- National Assembly Library, Director (1996.3-1998.3)
- Emstone, CEO (2001.6-present)

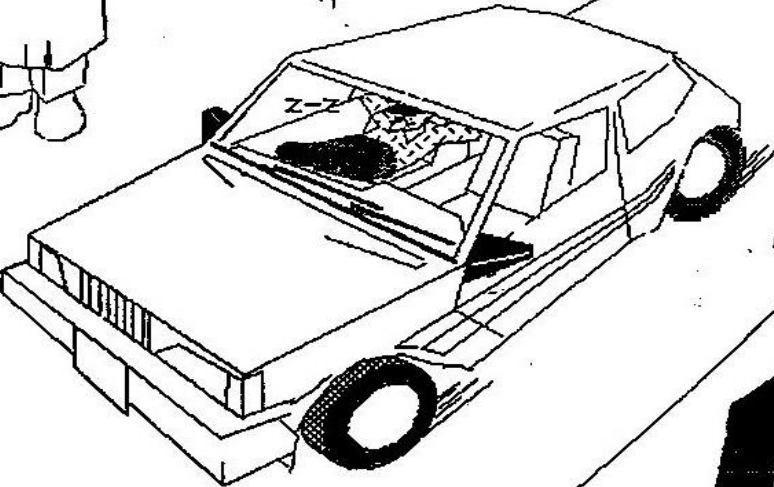
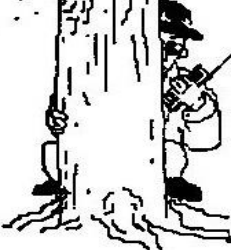
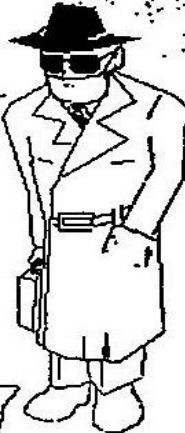
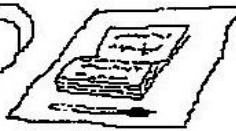


비가 오려나
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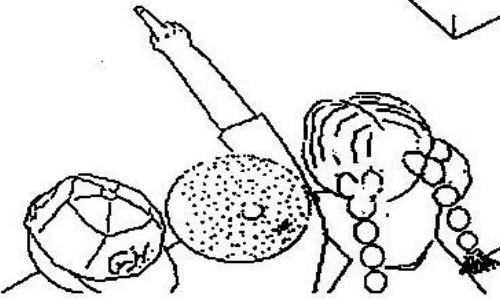
달마는 왜
동쪽으로 갔을까요?



사주
팔자



2001년의
여느날



We'll talk about...

- (a bit of) History
 - 2nd Industrial Revolution
 - 3rd Industrial Revolution
- Technical Basis for 3rd Industrial Revolution
 - Networked Home & Society
 - Technical Evolutions in IT
- (a bit of) Future
 - Embedded Systems & IoT
 - 4th Industrial Revolution?

First 5 Tycoons in USA

- Pioneers for 2nd Industrial Revolutions
 - Vanderbilt: Railroad
 - Rockefeller: Oil
 - Carnegie: Steel
 - J.P. Morgan: Investment (US Steel & GE)
 - * Edison (GE) vs Tesla (Westinghouse)
 - Ford: Automobile

IT Pioneers – I (3rd Industrial Revolution)



Companies	Major Contributions
IBM	Main Frame, FORTRAN, IT Service
AT&T	Communication, Unix/C
Intel	Micro Processor (CPU)
MS	DOS/Windows
Apple	GUI & Mac, iPhone, iWatch
Oracle	RDBMS, ERP (Enterprise Resource Planning)



Companies	Major Contributions
Sun	WorkStation, Client/Server Computing, Java
Samsung	Home Appliance, Memory, Mobile Phone
Google	Big Data, Un-manned Vehicle
Amazon	Internet Shopping, Drone
Facebook	SNS

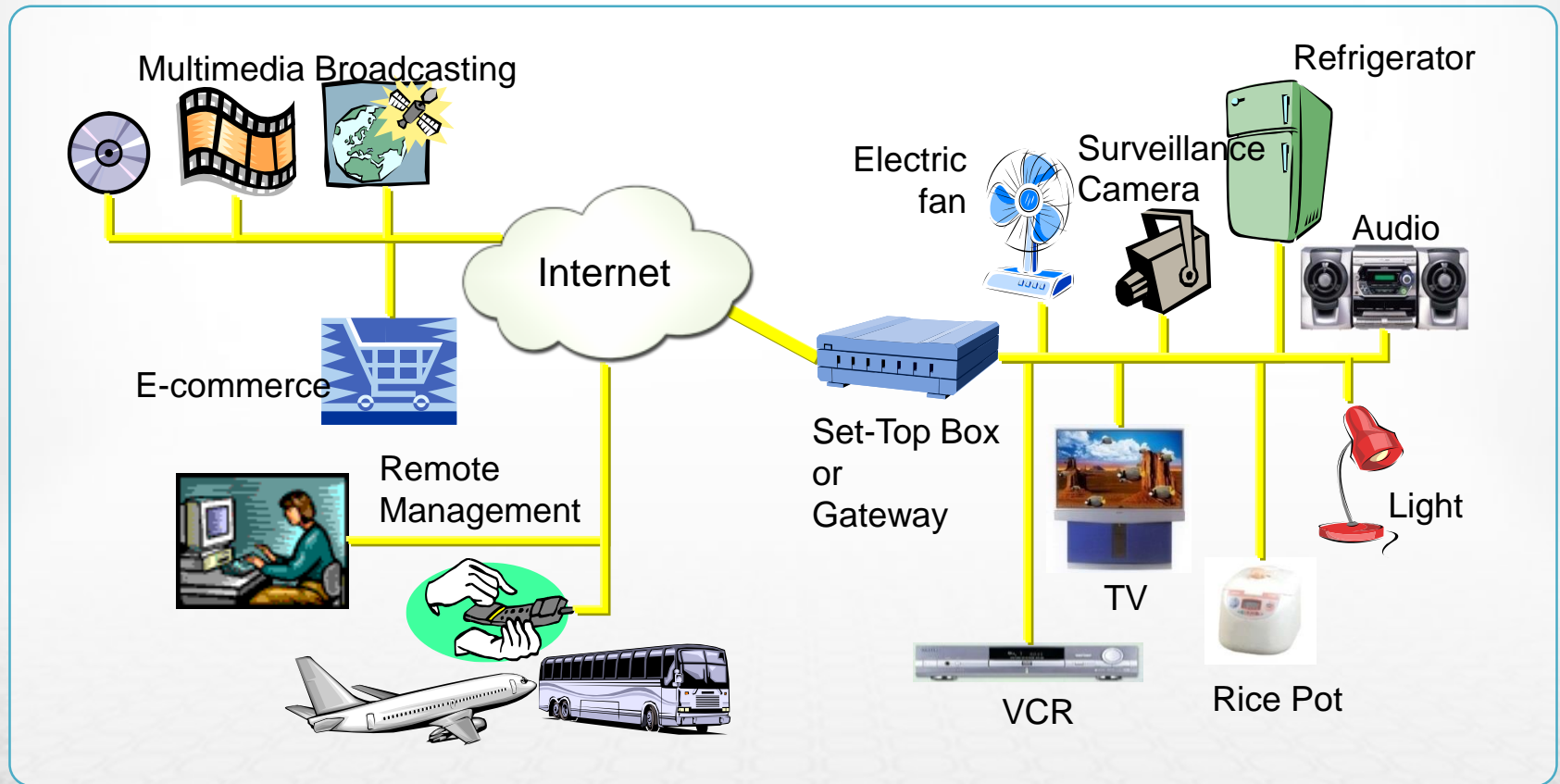
We'll talk about...

- (a bit of) History
 - 2nd Industrial Revolution
 - 3rd Industrial Revolution
- **Technical Basis for 3rd Industrial Revolution**
 - **Networked Home & Society**
 - **Technical Evolutions in IT**
- (a bit of) Future
 - Embedded Systems & IoT
 - 4th Industrial Revolution?

Networked Home & Society

- Computers are embedded everywhere & networked

Information electric home appliances are next-generation home apps. which can connect to wire/wireless network

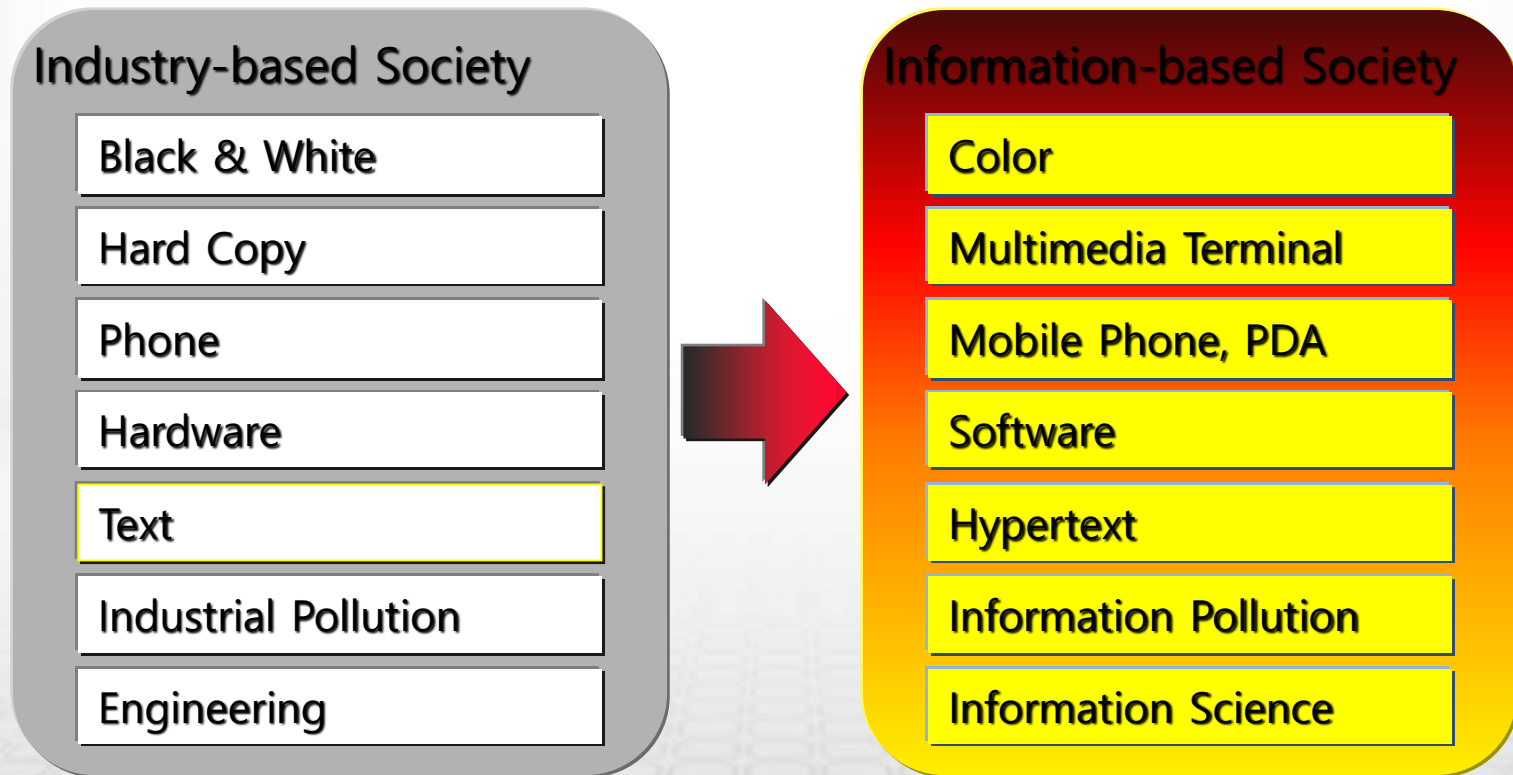


Mobile Evolutions



Information Society

✦ From Industry-based (2차산업) to Information-based (3차산업)



Technical Evolution

-What makes this possible?

Computer

- ◆ Digital Evolution (0 and 1)
- ◆ Fast Calculation
- ◆ Mass Data Storage

Data Networks

- ◆ Information Highway
- ◆ Infra for New Society

Multimedia Data

- ◆ Text, Voice, Image, ...
- ◆ Multiplexing all information
- ◆ Compression (Mpeg)

Internets

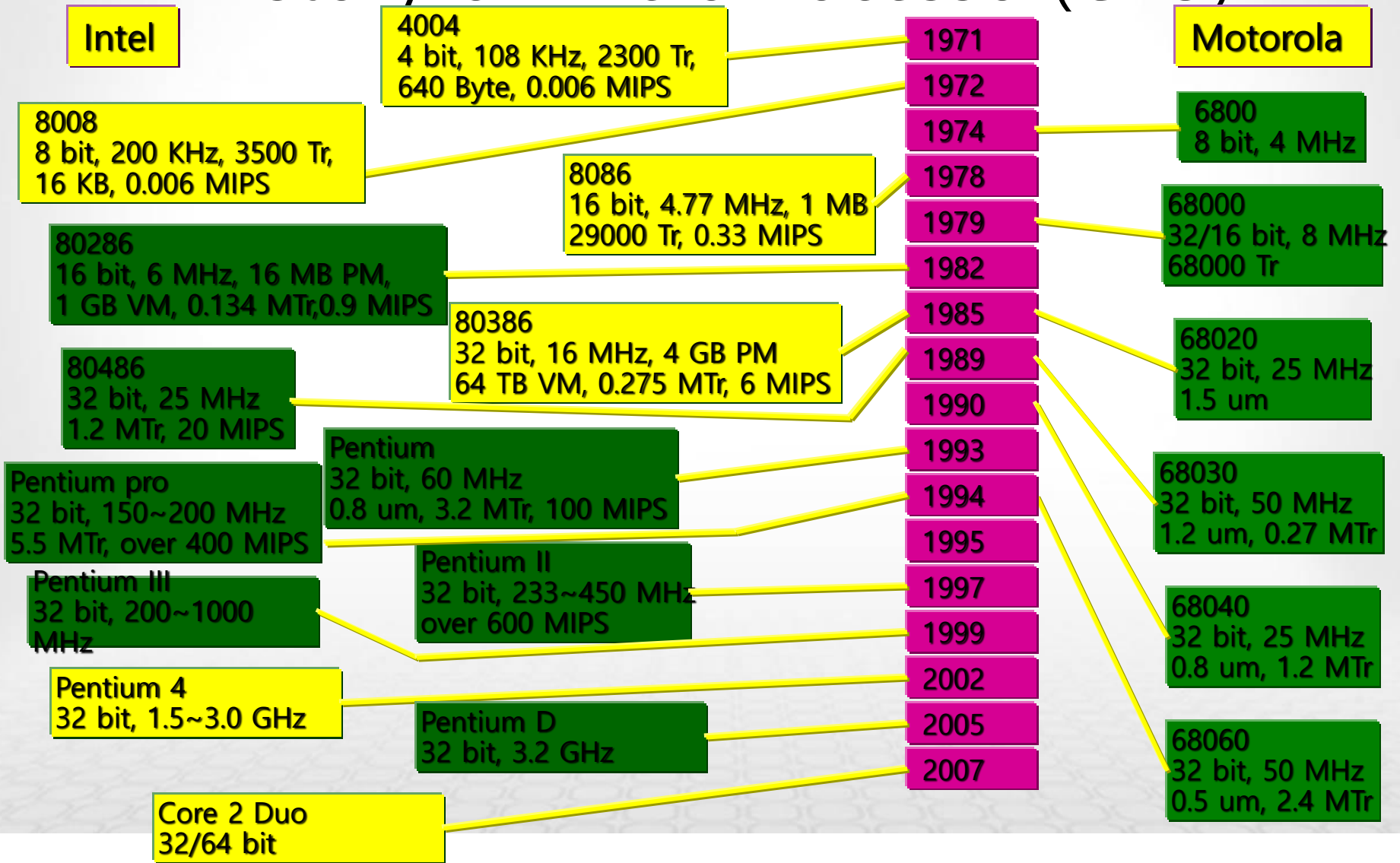
- ◆ Globalization
- ◆ Cyberspace

Speed of Computer HW

- Time for "add" instruction

1944	MARK-1	333 msec
1951	UNIVAC-1	282 μ sec
1964	CDC-6600	300 nsec
1988	Cray-Y/MP	20 nsec(6 nsec cycle time)
2000	Intel Pentium III 1 GHz	1 nsec
2003	Intel Pentium 4 3 GHz	0.3 nsec

History of MicroProcessor(CPU)



Current Technology Hardware

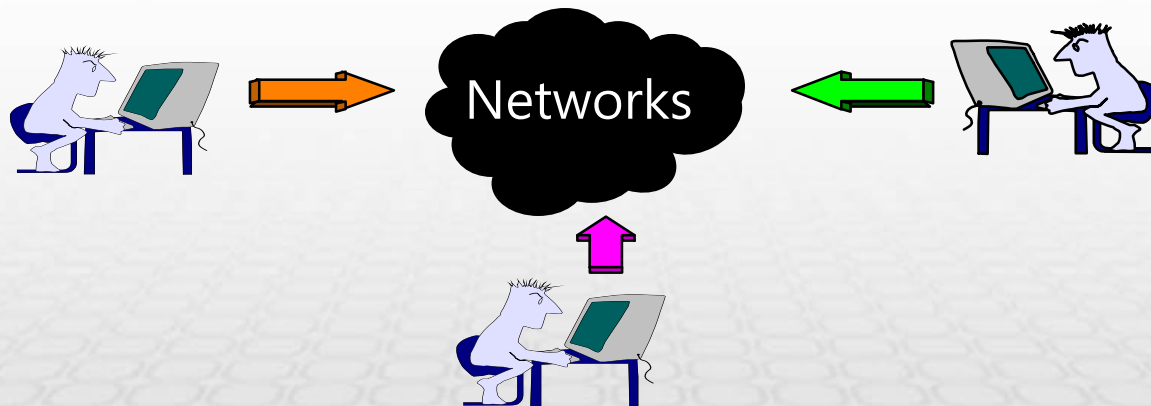
- 64 bit CPU
- Over GHz Clock
- RISC (Reduced Instruction Set Computer) vs CISC (Complex Instruction Set Computer)
- ASIC (Application Specific Integrated Circuit)
- SoC (System on Chip)
- Multicore CPUs: Currently up to 18 cores

Communication?

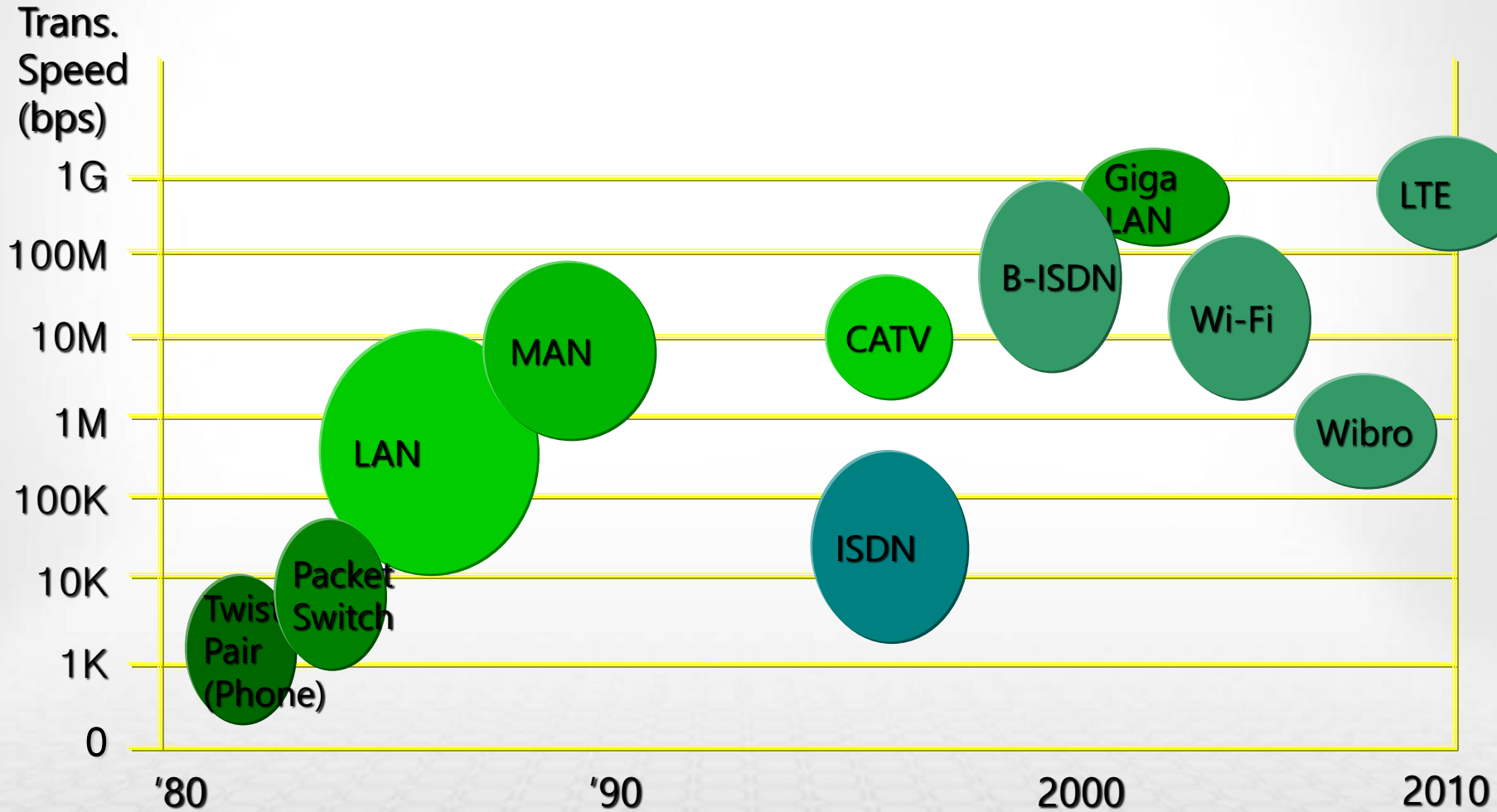
- Person to Person (Voice: Analog)



- Computer to Computer (Data: Digital)



Communications Network



Internet (1)

- Internet
 - DARPA Project (1968)
 - IP Network (Link between TCP/IP LAN and other LAN)
 - HANA/SDN (1988, First service in Korea)
 - Security problems
- Internet service
 - Remote Login
 - Email service
 - FTP (File Transfer Protocol) → HTTP for Web

Internet (2)

- WWW (World Wide Web)
 - Hyper Text Mark-up Language & HTTP Protocol
 - Browser for Integrated Internet Service
 - Microsoft Internet Explorer
 - Netscape Navigator, Mozilla, .. etc

Multimedia Data

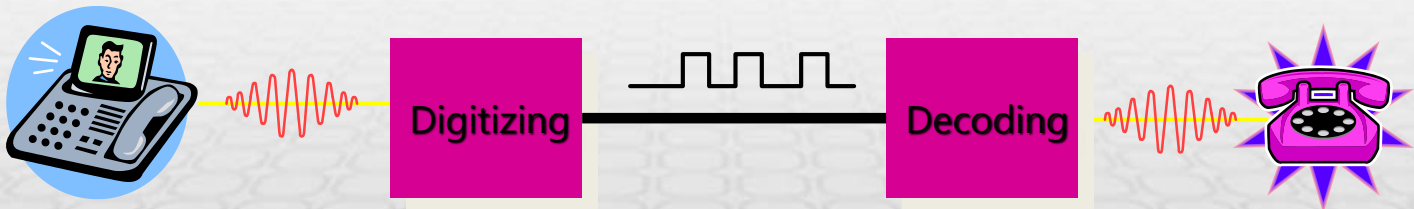
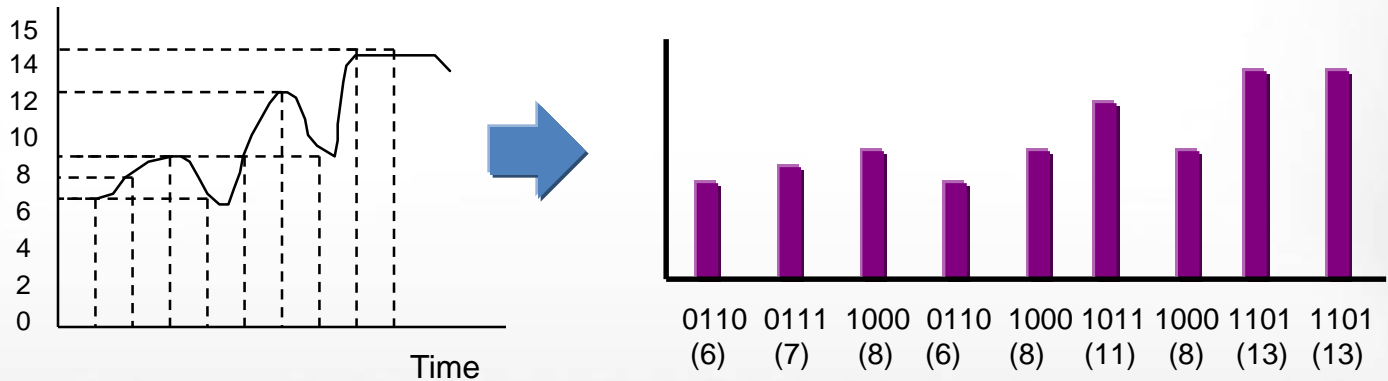
- Multiplexing different types of data
 - Text + Voice + Image + ...
 - Digital Data
 - Analog Data: Voice, Image, ...
- How to Digitize the Analog Data
 - Sampling
 - Time-wise sampling: Voice
 - Space-wise sampling: Image (Pixel)
 - Quantization (or Encoding)

Digitalize Image

- Pixel
 - A single point in the image
 - Number of pixels result in “Resolution” of image
 - For example, 1M pixels vs 10M pixels image
- Quantization
 - Number of different colors
 - 256 colors using 8-bit, 64K colors using 16-bit
 - 1M pixels with 16-bit colors requires 16M-bit memory (or 2M bytes)

Digitalize Voice

- Digitalize the Voice by Time-wise sampling
 - Sampling (usually 8,000 samples per 1 second for voice)
 - # of samples per second = data (signal) frequency * 2
 - Quantization (usually 8-bit for a sample)
- Digital transmission



Amount of Data Required

Data	Services	Total data
Text	1 Million characters	8 Mbps
Audio	Phone (4 KHz) Stereo Radio (15KHz)	64 Kbps 1.4 Mbps
Video	VCR (non compressed) VCR (compressed) HDTV (non compressed) HDTV (compressed)	100 Mbps 5 Mbps 400 Mbps 100 Mbps
Still Image (1 cut per sec)	1024 X 1024, 8 bit/pixel (256 color) 2048 X 2048, 8 bit/pixel (256 color) 4096 X 4096, 24 bit/pixel (16 million color)	8 Mbps 32 Mbps 400 Mbps

■ Hypertext = Audio + Video + Text + etc.

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 - Embedded Systems & IoT
 - 4th Industrial Revolution?

미래를 알 수 있다?!?

컴퓨터와 IT 그 진화와 미래

컴퓨터를 알면 미래가 보인다

우리가 앞으로 살아가야 할 21세기와 그 이후의 삶에 크나큰 영향을 미치게 될, 20세기의 위대한 발명품은 과연 무엇일까요?
그것은 두말할 나위 없이 컴퓨터라 할 것입니다.

송실대학교 컴퓨터학부



Future of Our Life!

- ❖ Ubiquitous Computing, Cloud Computing
- ❖ Wearable Computers
- ❖ Smart Phone, App, Web, SNS(Social Network Service)
- ❖ Big Data & Data Mining
- ❖ Embedded Systems (Vehicle, Robots, Dron,)
- ❖ IoT (Internet of Things)
- ❖ 3D Printer
- ❖ FIN Tech (Financial Technplogy)
- ❖ IT Convergence
 - for Products, Processes and Services

로봇과 무인 자동차

What's the Difference between the Two?



CREST (Center for Realtime Embedded System Technology) <http://realtime.ssu.ac.kr>

What is Embedded Systems?

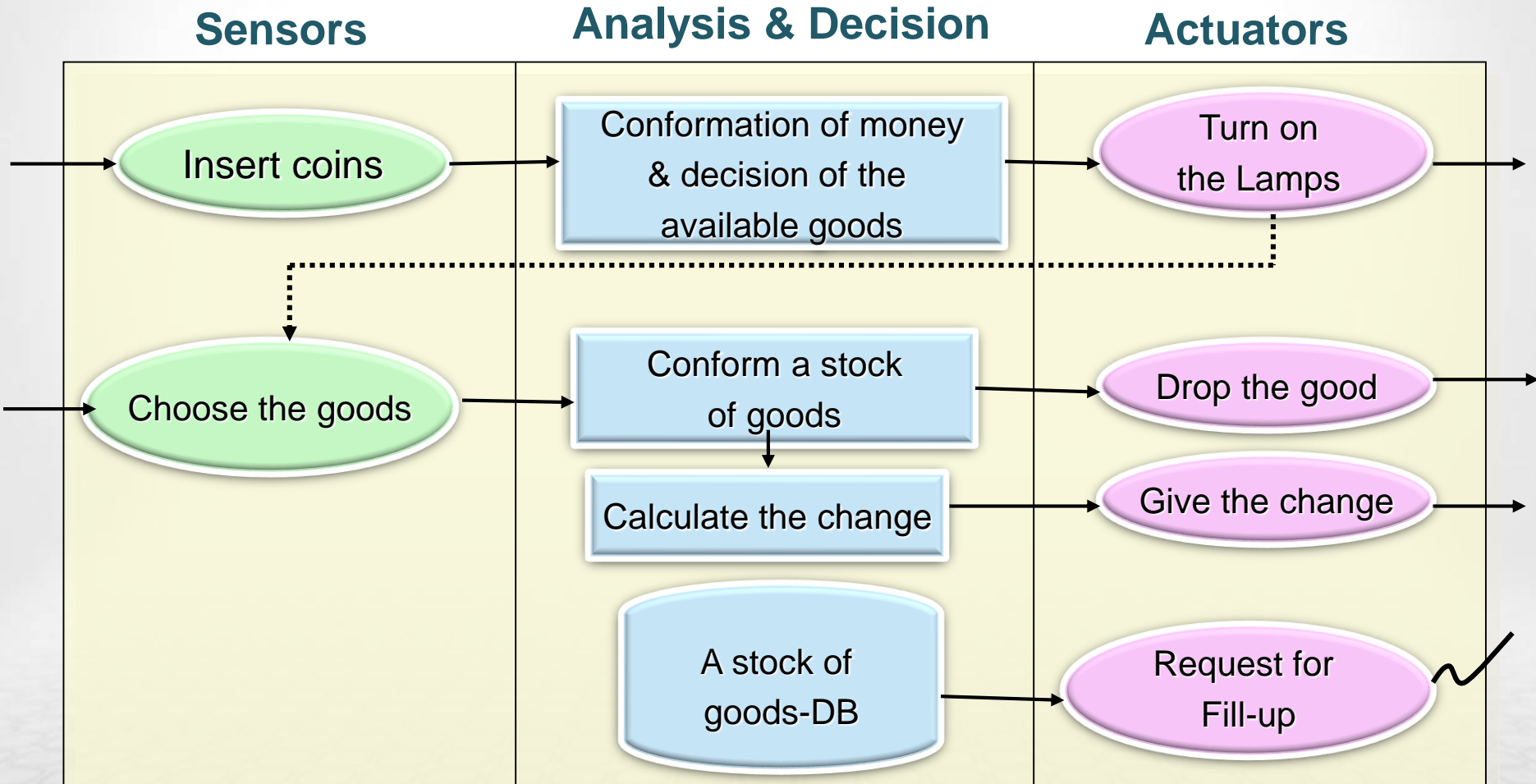
- ❖ Computers Inside a Product (or a System)
- ❖ Any device that includes a programmable computer but is not itself a general-purpose computer.
- ❖ “Combination of HW and SW to perform a specific functions within a target system”
 - H/W : CPU/Controller, Memory, Sensors/Actuators
 - S/W : OS, Device Driver, App. program, Networks

● Vending Machine



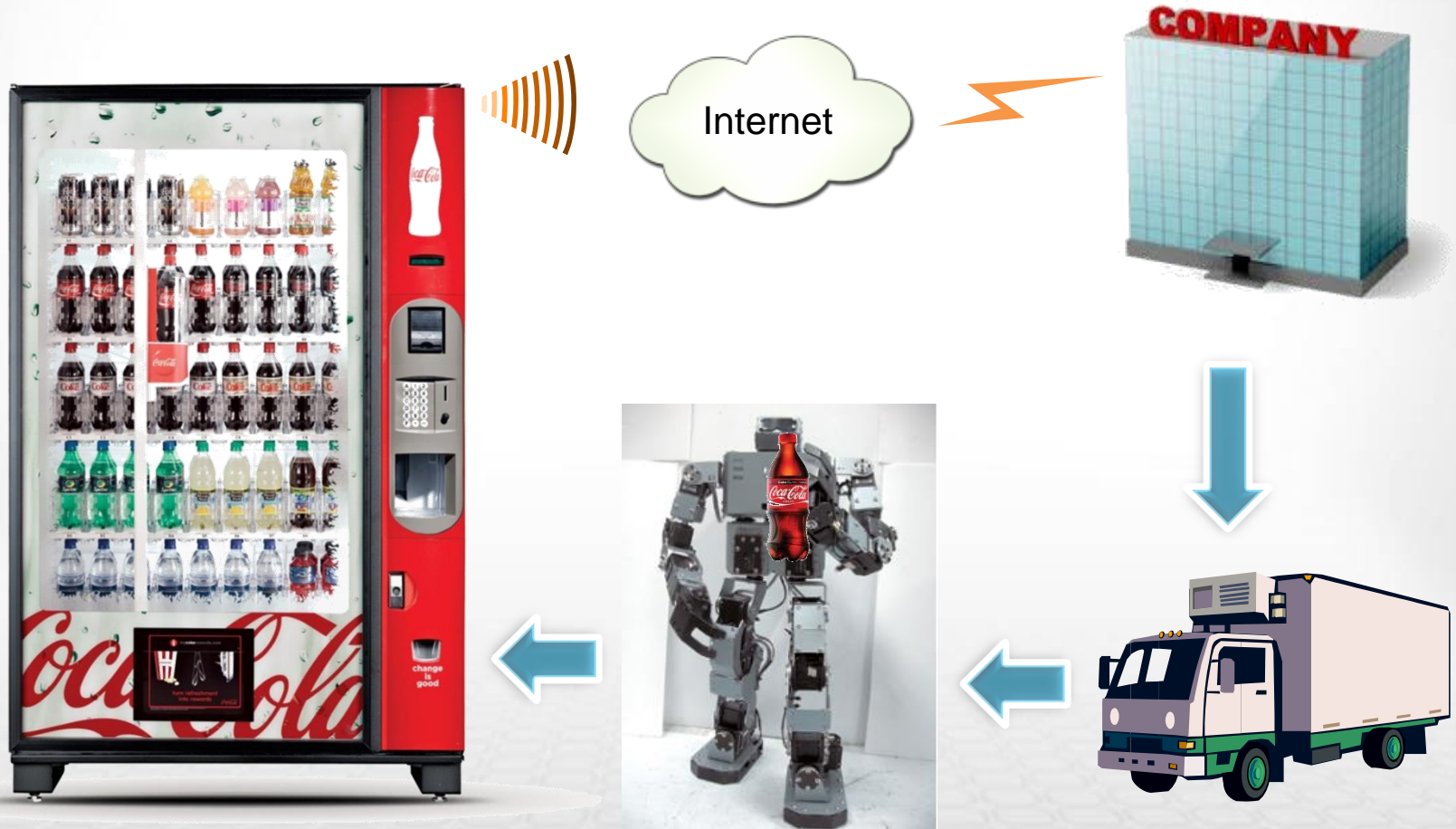
Example of Embedded System (1/2)

Flows in Embedded System



Example of IoT (Internet of Things)

● 콜라가 필요할 때?



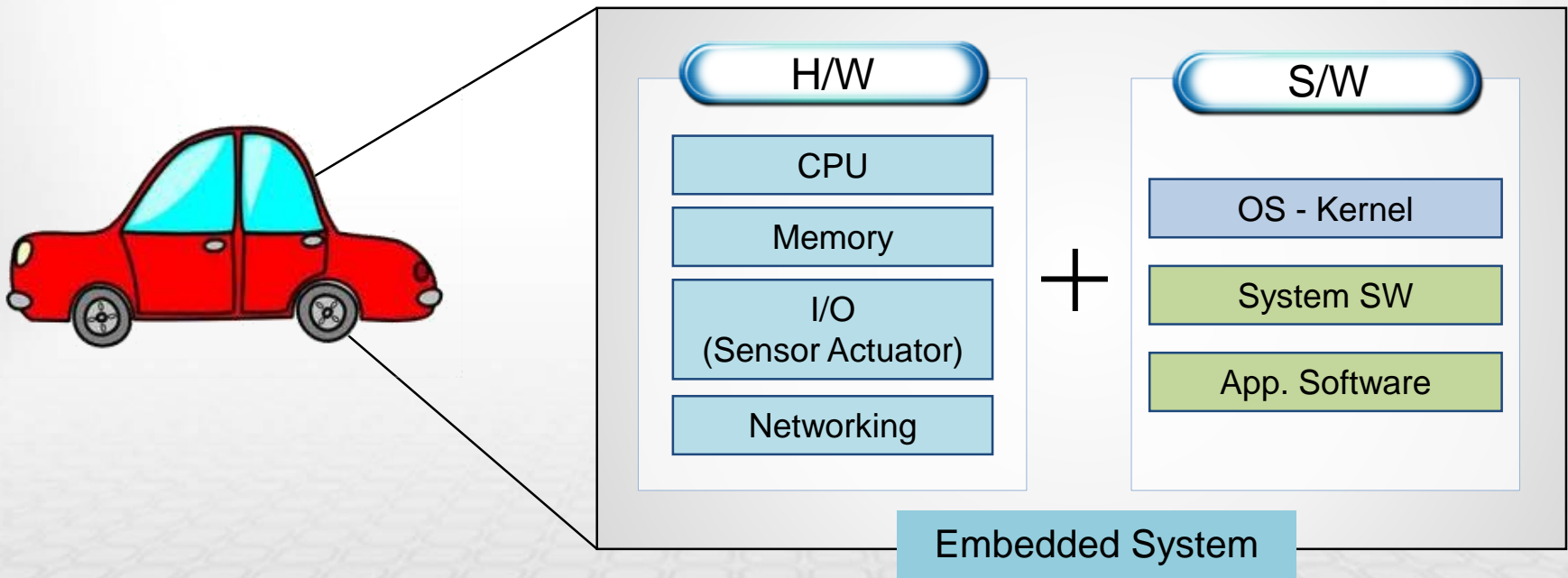
Components of Embedded System

- Embedded Hardware

 - CPU, Memory, I/O, Sensor/Actuator, Networks

- Embedded Software

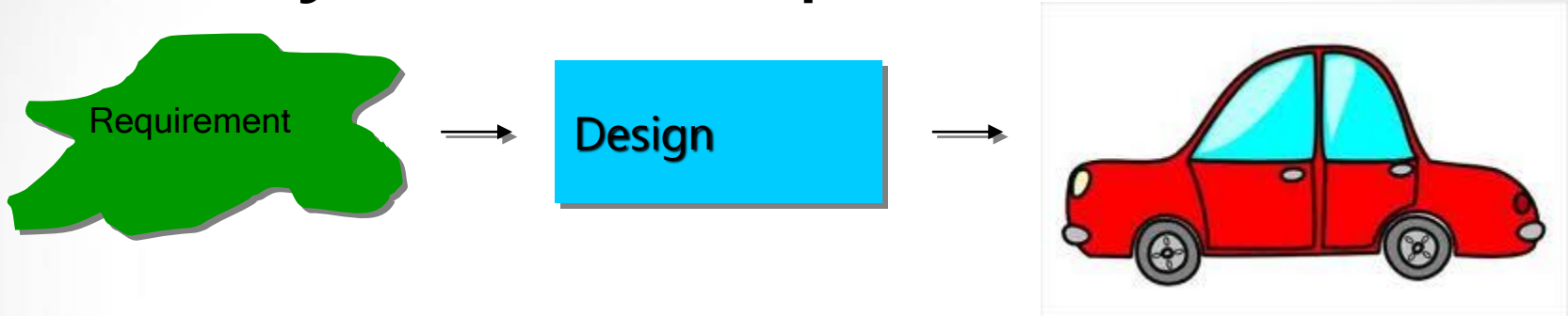
 - OS, System SW, Application SW



What is a Real-time system?

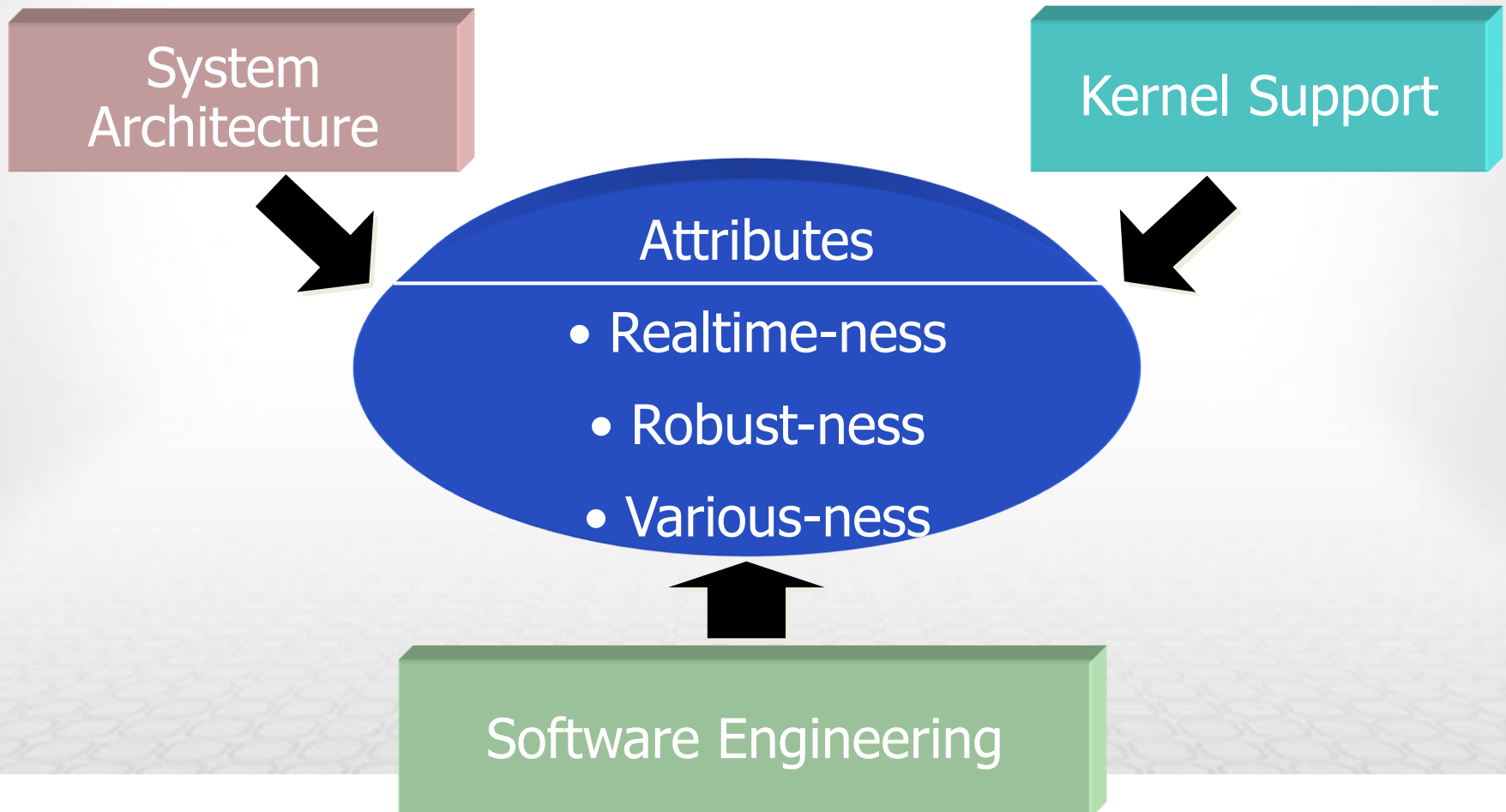
- Real-time systems
 - correctness of system operation depends on temporal characteristics as well as logical and functional characteristics
- Timing constraints
 - deadline, period, execution time, etc.
- Real-time applications
 - those that must satisfy timing constraints, typically, hard real-time

System Requirement



- Functional Requirements
- Performance Requirements
 - Temporal
 - Reliability
- ...
- Cost and Time

Three Aspects in Embedded (Real-time) System

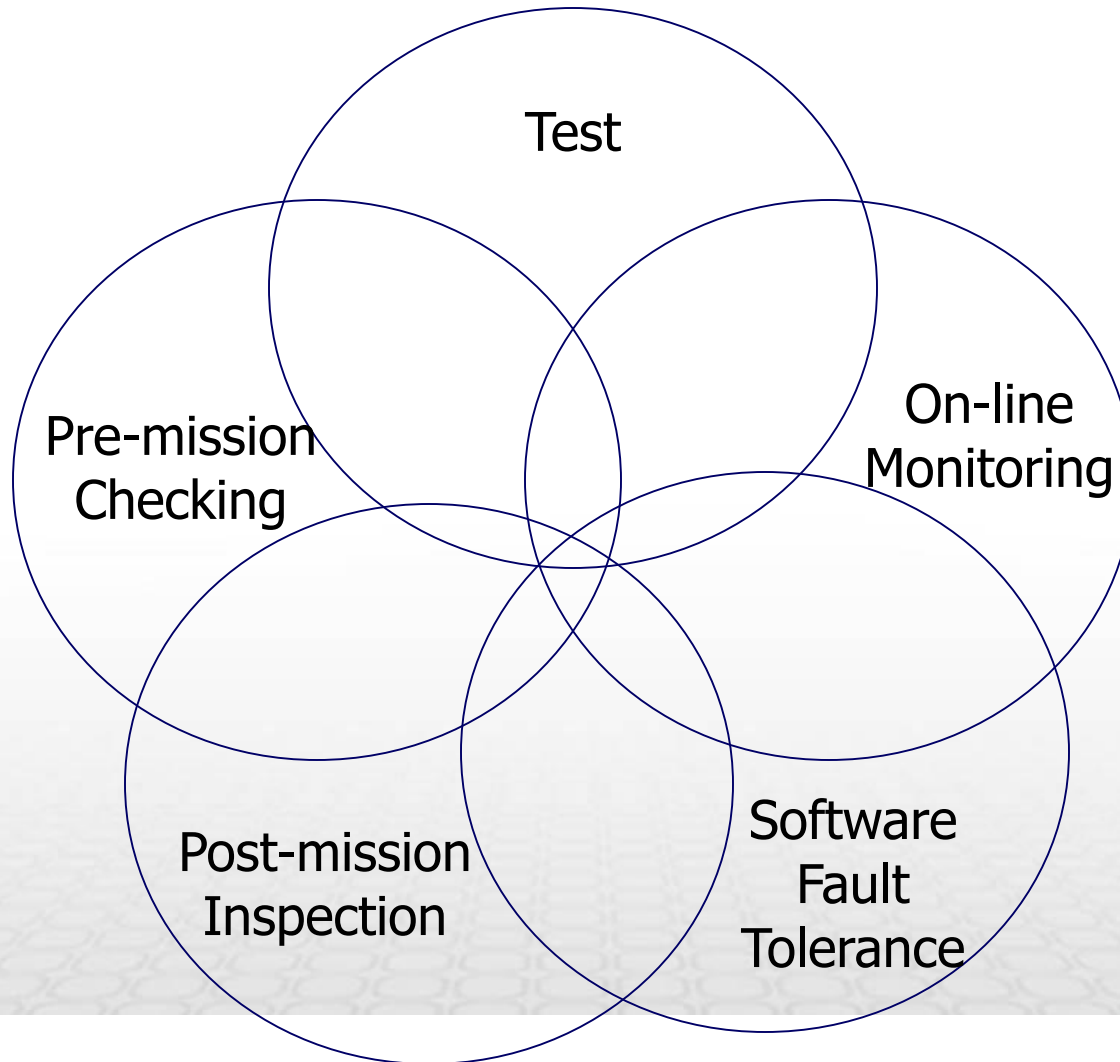


Role of Integrated Diagnostics

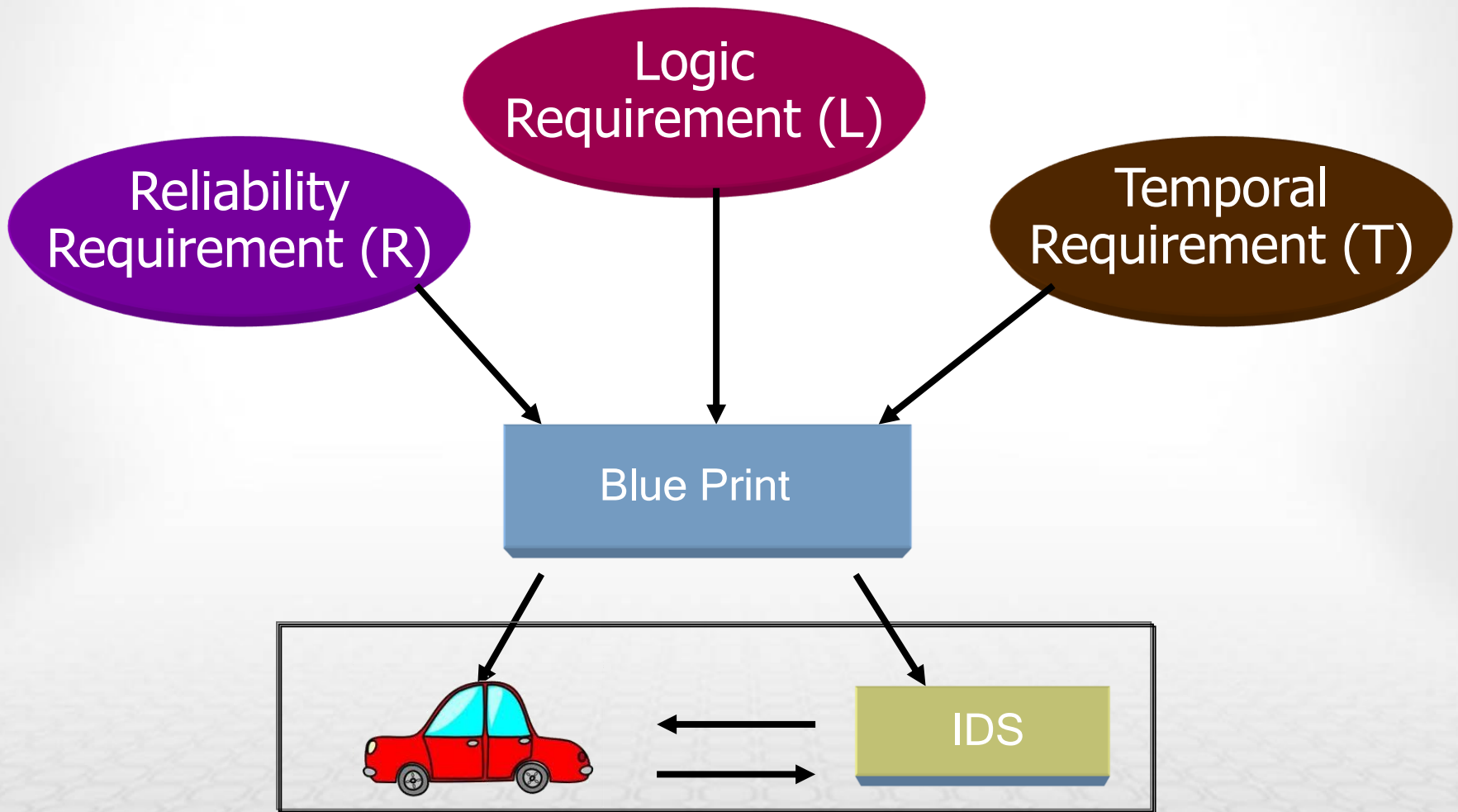
- Suggest test procedures and methods for system components as well as for the integrated system
- Suggest fault tolerance schemes appropriate for the system
- Develop off-line monitoring system
- Develop on-line monitoring system

Extract the requirement of the diagnosis software from the system's requirements

Integrated Diagnostic Software



A Promising Approach





안심하고 살 수
있나요?

We talked about...

- 2nd Industrial Revolution
 - Based on Oil and Electricity
 - Construction and Transportation (Train, Car, Airplane)
- 3rd Industrial Revolution
 - Based on IT (Computer & Network) Technology
 - Automation and Information Highway
- 4th Industrial Revolution?
 - Based on What? Software, AI ??
 - Beyond Automation

- ❖ From “computer-aided” to “computer-controlled” society
 - Dependability is the key factor

- ❖ Problems
 - ➡ Too much Data
 - ➡ Security
 - ➡ Safety
 - ➡ Morals: High Intelligent and Dangerous Cyborg will be Present!

- ❖ Nevertheless, Cheers!
 - New Jobs & New Opportunity!!!

??? 그런데, 4차산업의 실체는? 인간이 하는 마지막 산업혁명?

❖ 소프트웨어 산업의 방향은?

- 중국 100만명 vs 한국 5만명 (1년 배출인력)
- 비관적, 그러나 포기할수는 없음: 1당100 => SW Venture
- 유력분야: Game/Entertainment, Embedded, 보안, 의료, AI...

❖ 창업 = Venture ?

- High Risk, High Return ?
- 네델란드 동인도회사

❖ 창업의 방향

- ▶ 일반IT기업: 성공확률 50% 정도여야 함 – 준비와 노력
- ▶ Real Venture: 성공확률 1% 정도