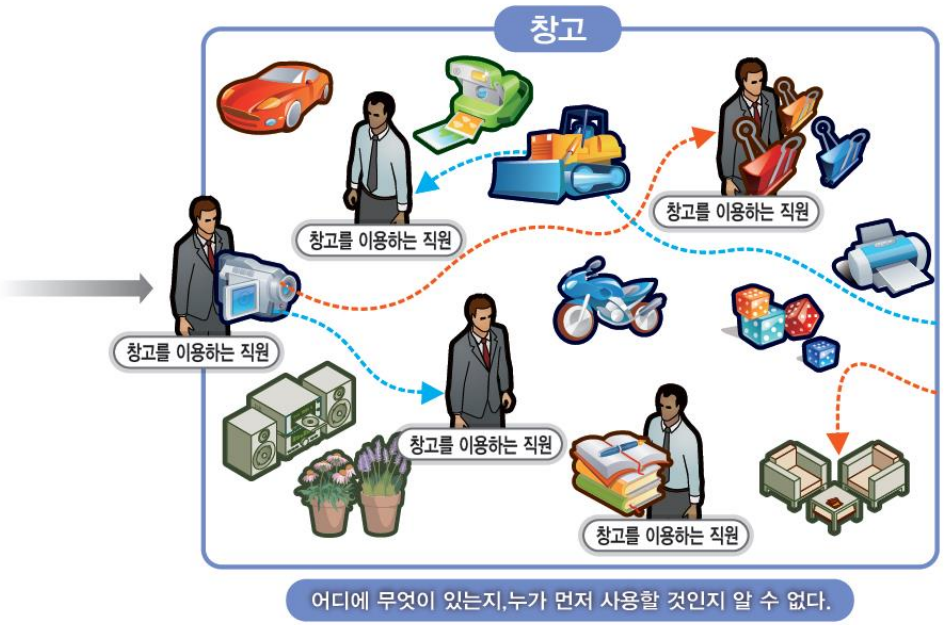
Database Technology

김 형주 교수
Internet Database Lab
서울대학교 컴퓨터공학부

Data Management



<혼란스러운 창고>

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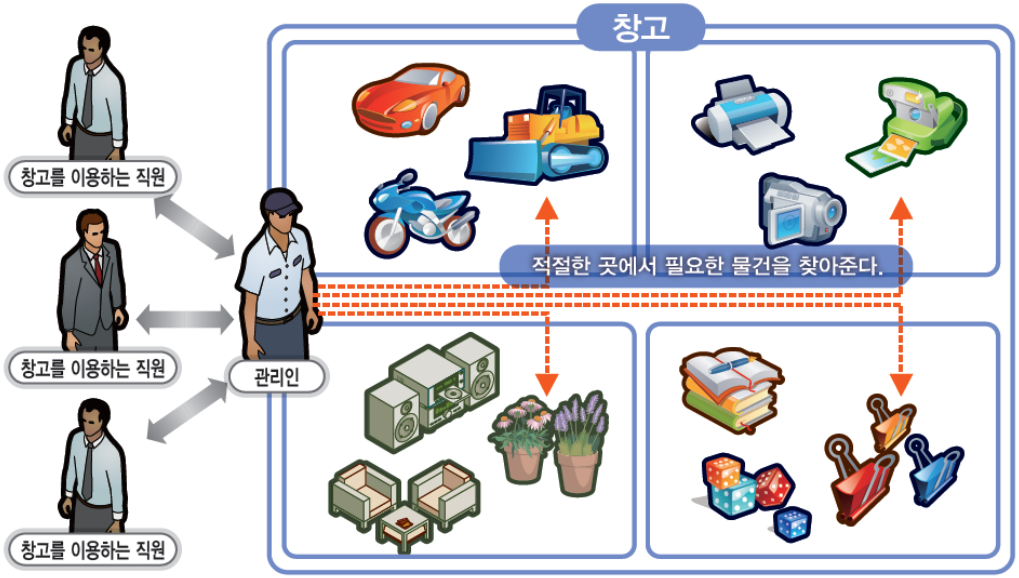
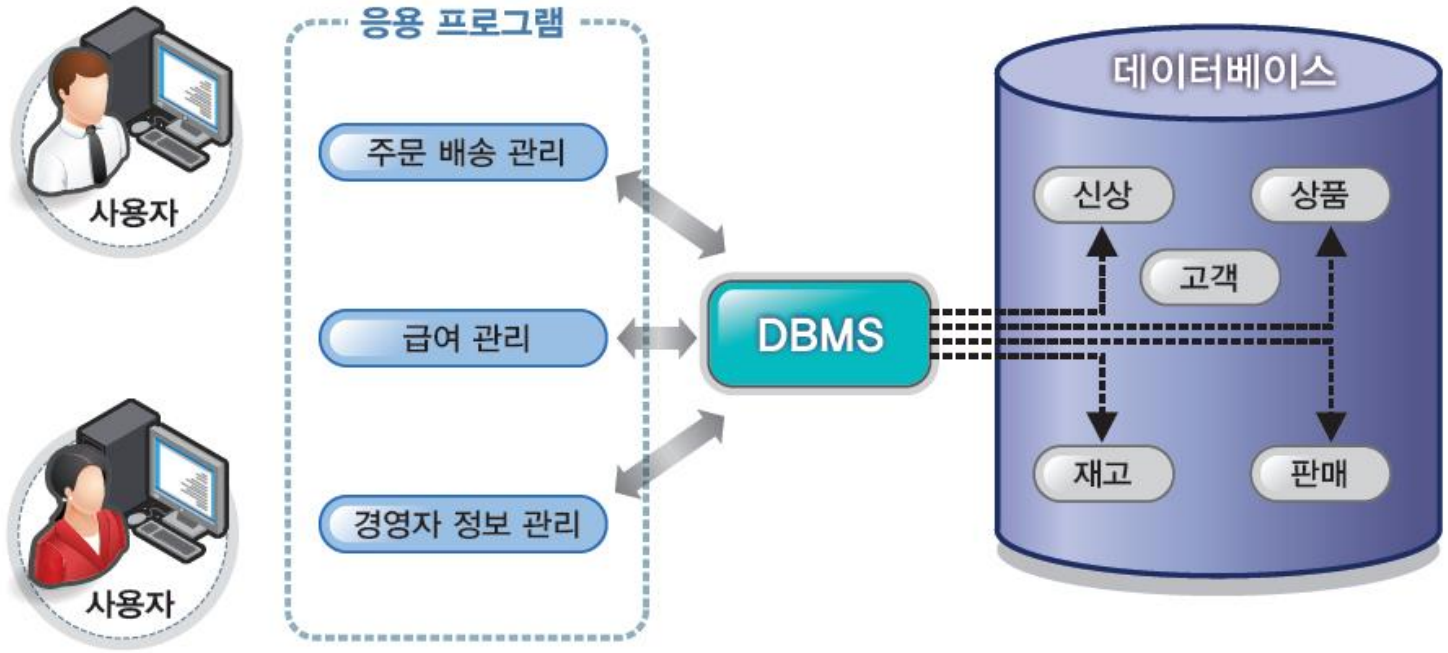


Data Management – Dedicated System

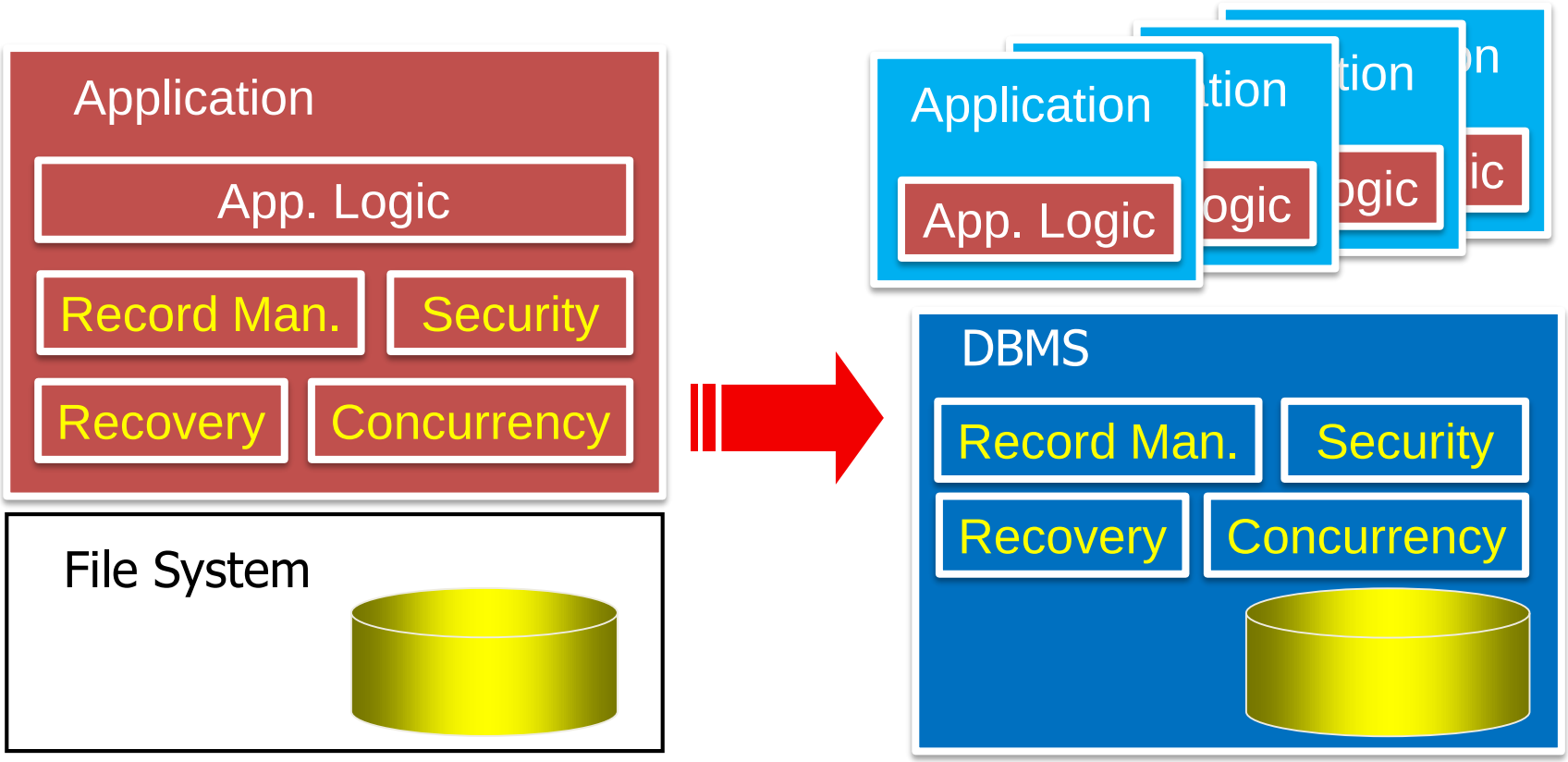


물건	데이터
창고	데이터베이스(디스크)
창고관리인	Dedicated System - DBMS
직원	응용 프로그램 또는 사용자

File Systems

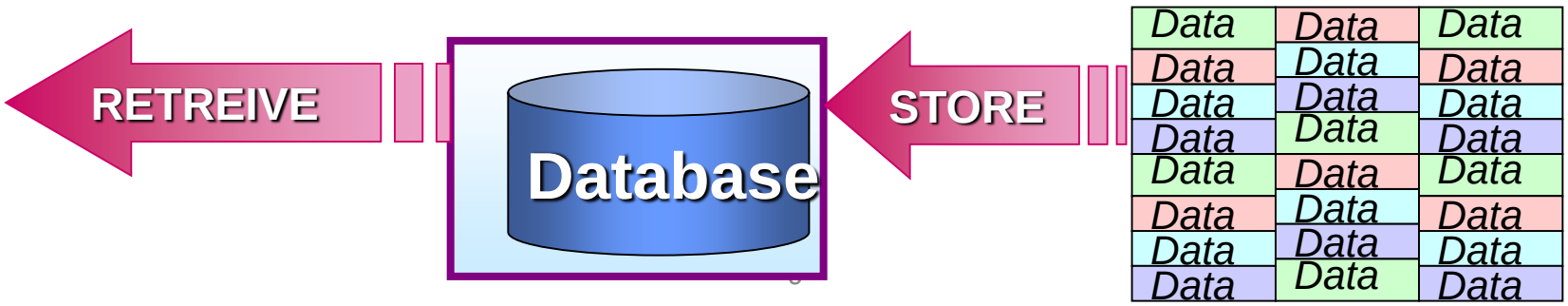
- File System
  - Core part of OS
  - Stores programs, data, documents, or anything
  - (in disk)
- Drawbacks:
  - Redundancy and Inconsistency
    - Multiple file formats, duplication of information in different files
  - Atomicity of updates
    - Failures may leave database in an inconsistent state with partial updates carried out
  - Concurrent access by multiple users
    - Concurrent accessed needed for performance

Database Management System (DBMS)



Data Base Management System (DBMS)

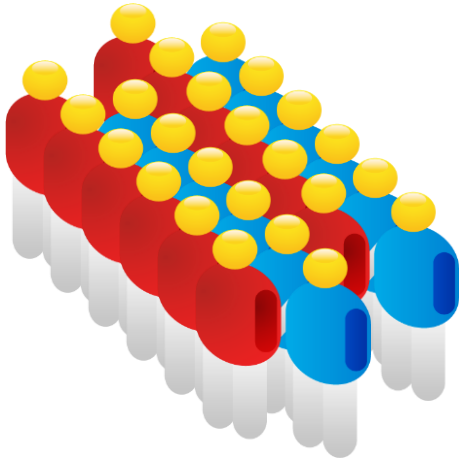
- Basic functionalities
  - Store and Retrieve massive data effectively
  - Provide "ad-hoc" queries
  - Provide concurrent accesses to data (transaction)
  - Keep the integrity of data (recovery) despite of failures
  - Provide standard platform for application SWs
  - Enforce security constraints on data



Simple Data Base

- Mobile phone accounting data

120KB record per call



Phone No	Name	station	Start-time	End -time
.....	.....	.....	.....	...
.....	.....	.....	.....	...

40M Persons * 120 Byte * 50 calls/day * 365 days
= 80000 G Byte / 1 year = 80 Tera Byte / 1 year

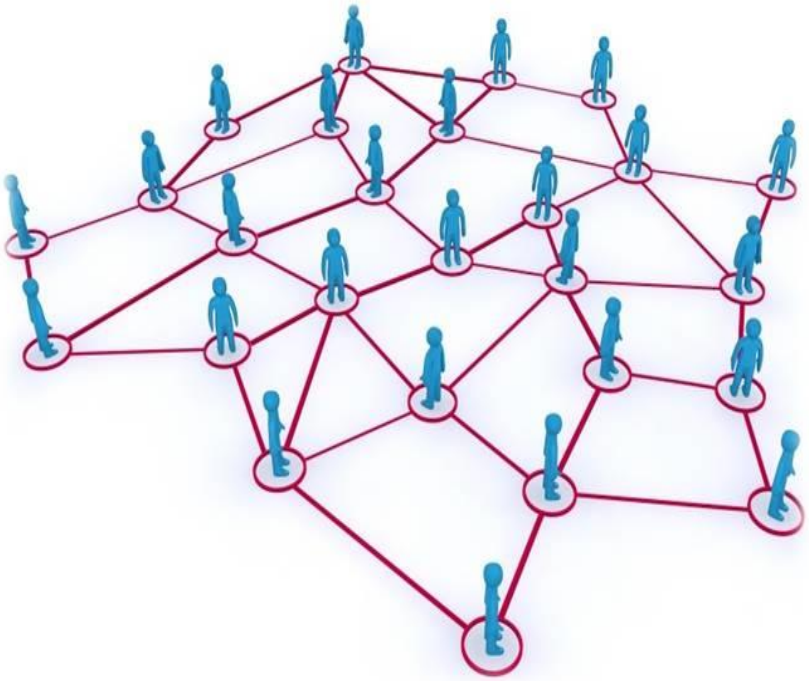
Fastly Growing Big Data Base

- NCBI (National Center for Biotechnology Information)

GenBank

- management of information of 165,000 species
- add 3 million new DNA sequences monthly

Enormous Data in Social Network

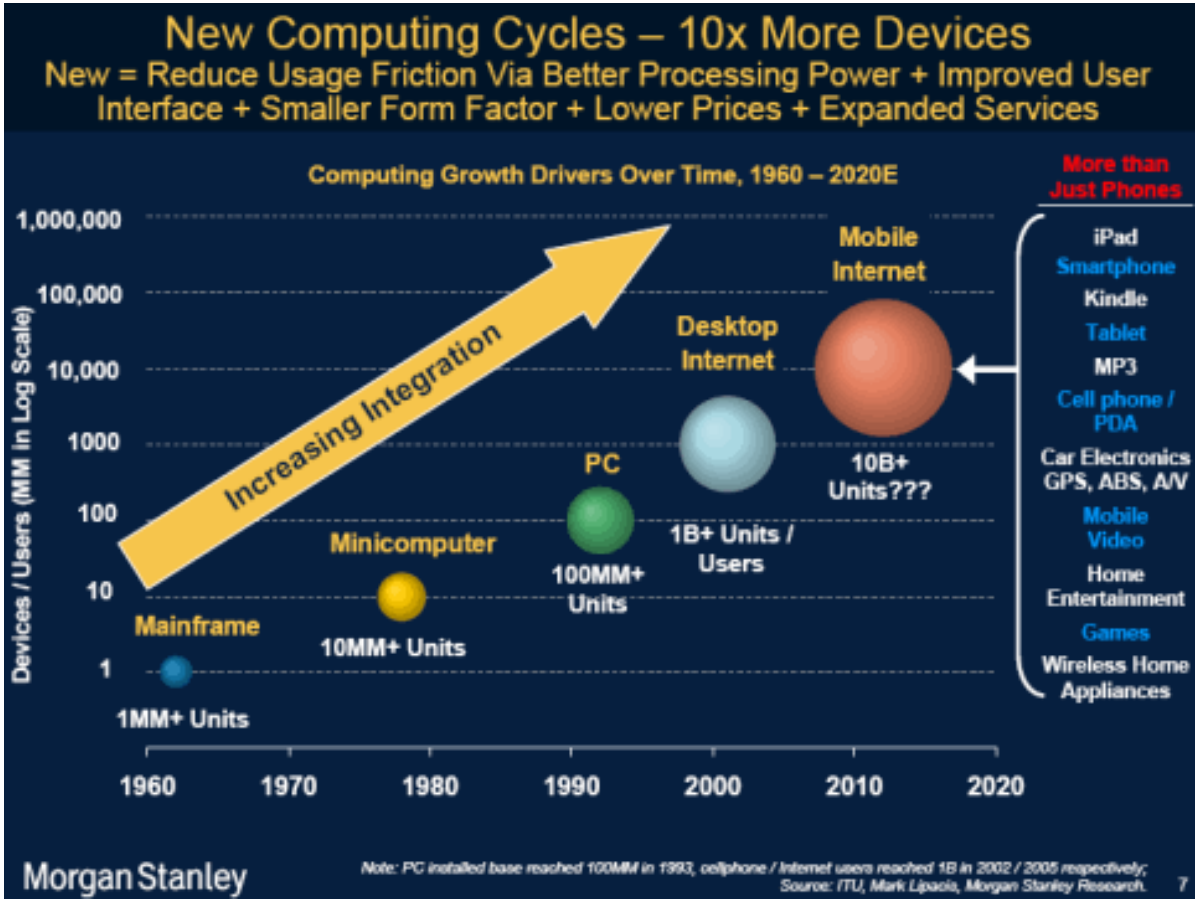


Web(Internet)을 소통과 협력의 도구로 활용

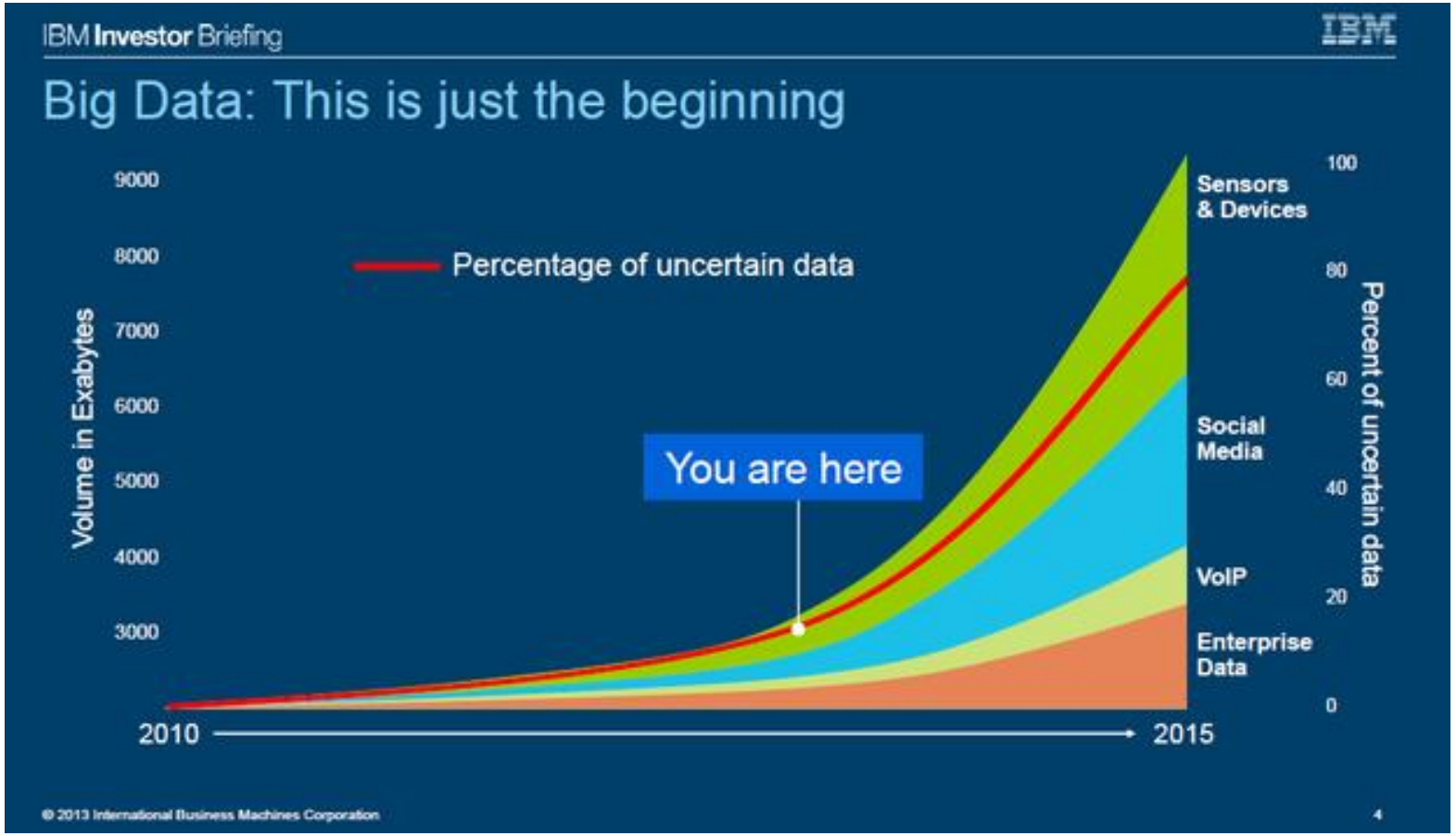
15,000,000,000 Smart Devices (5000억개)

50

- *Programmable (프로그램 작동이 가능하고)*
- *Internet connected (인터넷 접속된)*

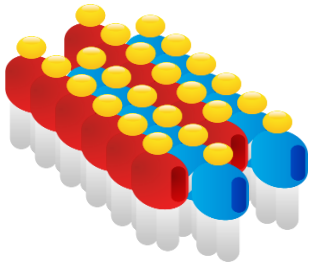


Data Explosion!

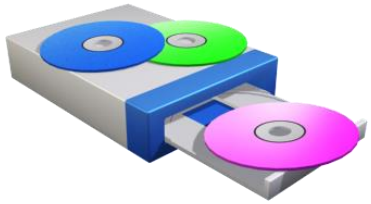


Role of DBMS [1]: Simple record search

- 주민번호 "840101-1212141" 인 학생의 수능 수학성적을 찾아라?



740,000명 * 5 records = 3,700,000 records



If 12ms is required for fetching a record & checking using a file system

3,700,000 * 12ms = 44.4K secs = *over 12 hours*

If we use DBMS, it will be less than 0.1sec!

Statistical processing for population census

DBMS

Search for the purchase pattern on customer groups

Search for the correlation between gene and disease

Role of DBMS[2] : Supporting Enterprise Applications

E-Commerce

CRM

ERP

SCM

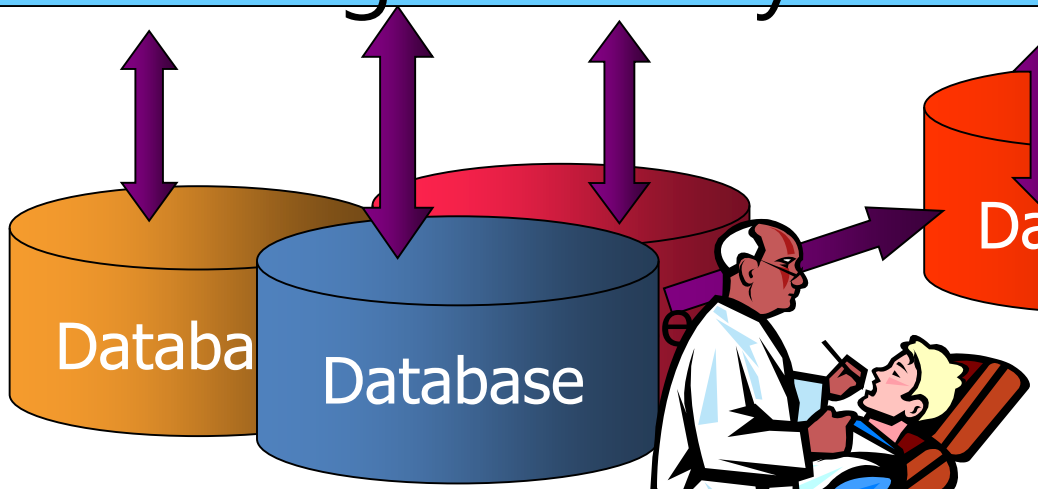
Data Warehouse

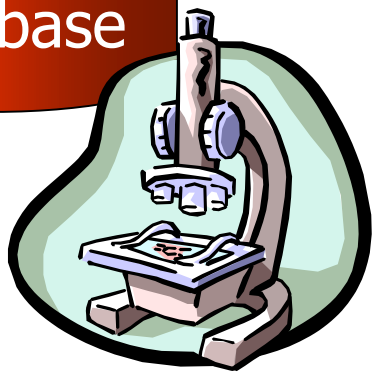
OLTP

MIS

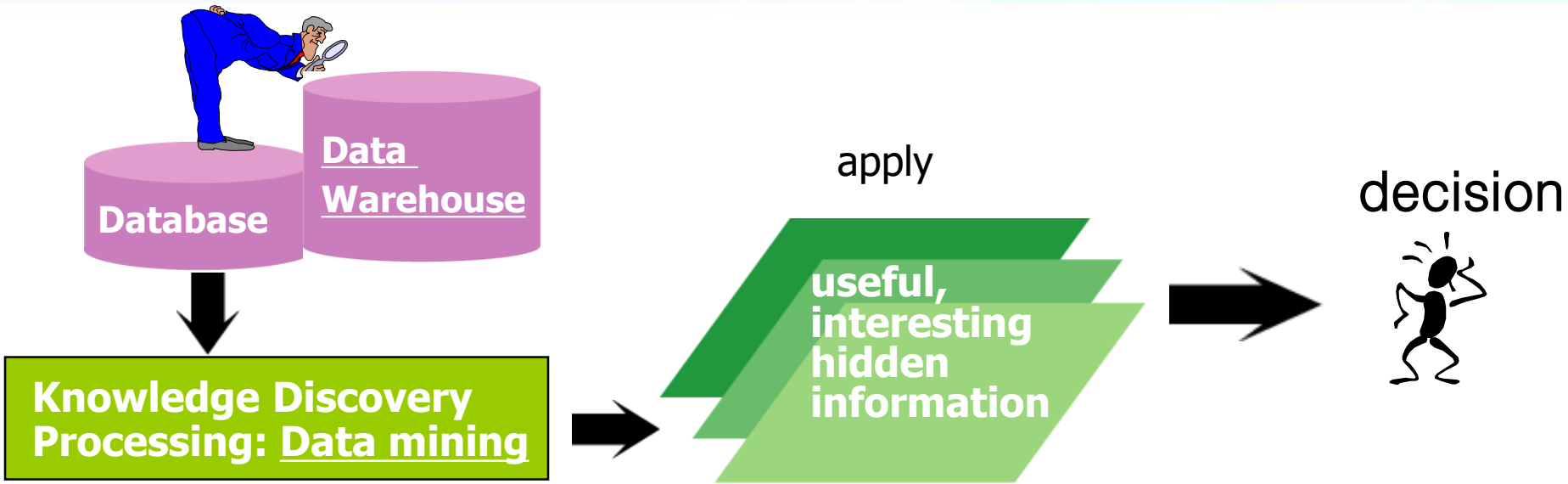
KM

Data Base Management System





Role of DBMS [3] : Even Knowledge Discovery!



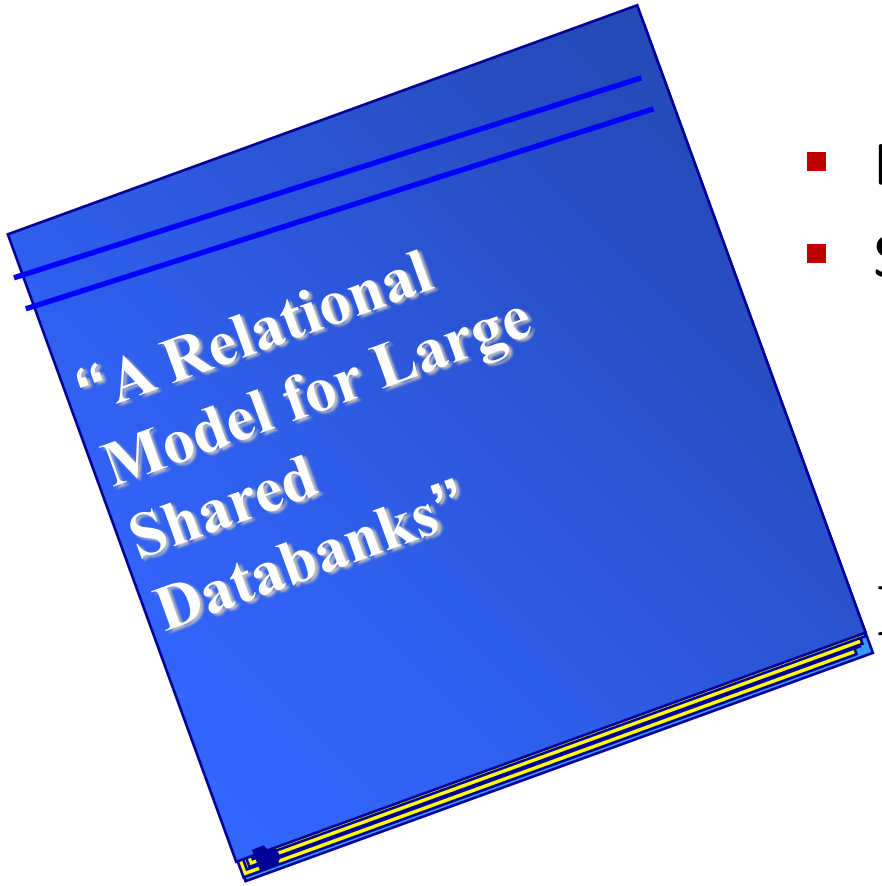
Data Analysis/Mining

* 빵과 과자를 사는 사람의 80%는 우유를 같이 산다
* 분유와 기저귀를 사는 사람의 74%는 맥주를 같이 산다

Decision Making

* 상품 진열대에 {빵, 과자, 우유}, {분유, 기저귀, 맥주}를 같이 진열
* 우유 소비를 조절하기 위해 빵, 과자 가격을 조정

In The Beginning...



- Everything in Table
- Set-oriented Query Language

E.F. Codd

-- 1970 CACM Paper

-- Turing Award

1970

A Sample Relational Database

customer-id	*customer-name*	*customer-street*	*customer-city*
192-83-7465	Johnson	12 Alma St.	Palo Alto
019-28-3746	Smith	4 North St.	Rye
677-89-9011	Hayes	3 Main St.	Harrison
182-73-6091	Turner	123 Putnam Ave.	Stamford
321-12-3123	Jones	100 Main St.	Harrison
336-66-9999	Lindsay	175 Park Ave.	Pittsfield
019-28-3746	Smith	72 North St.	Rye

(a) The *customer* table

account-number	*balance*
A-101	500
A-215	700
A-102	400
A-305	350
A-201	900
A-217	750
A-222	700

(b) The *account* table

customer-id	*account-number*
192-83-7465	A-101
192-83-7465	A-201
019-28-3746	A-215
677-89-9011	A-102
182-73-6091	A-305
321-12-3123	A-217
336-66-9999	A-222
019-28-3746	A-201

(c) The *depositor* table

SQL: supporting ad-hoc queries

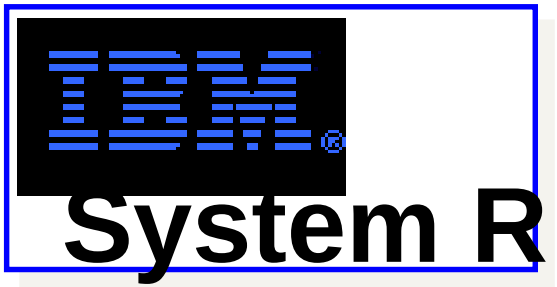
- SQL: widely used commercial query language
  - E.g. Find the name of the customer with customer-id 192-83-7465

```
select   customer.customer-name
  from   customer
 where   customer.customer-id = '192-83-7465'
```

  - E.g. Find the balances of all accounts held by the customer with customer-id 192-83-7465

```
select   account.balance
  from   depositor, account
 where   depositor.customer-id = '192-83-7465' and
         depositor.account-number = account.account-number
```

Experimental RDBMS Prototypes



INGRES
At UC Berkeley

1970 → **1979**

Commercial RDBMS Products

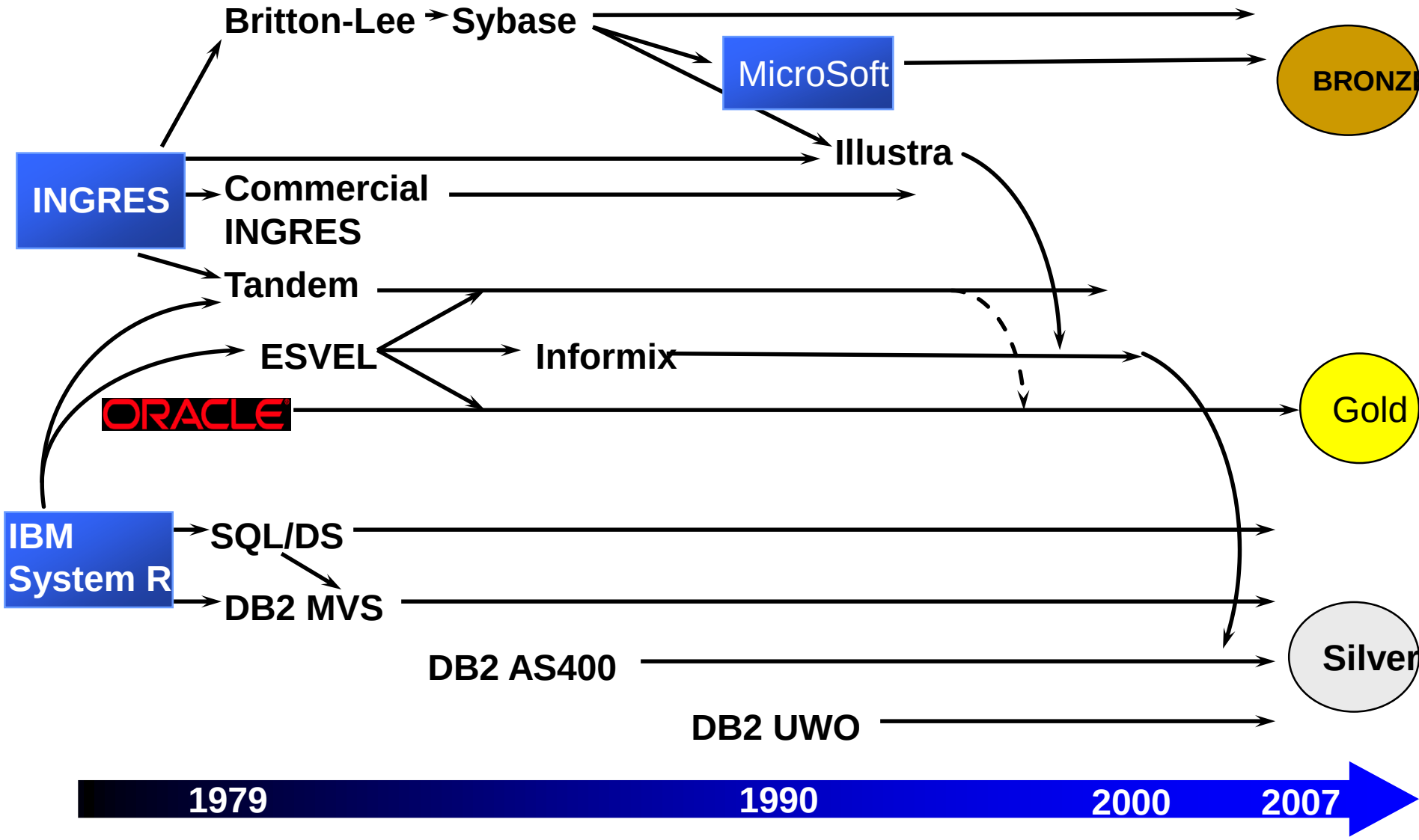
ORACLE

INGRES
(commercial)

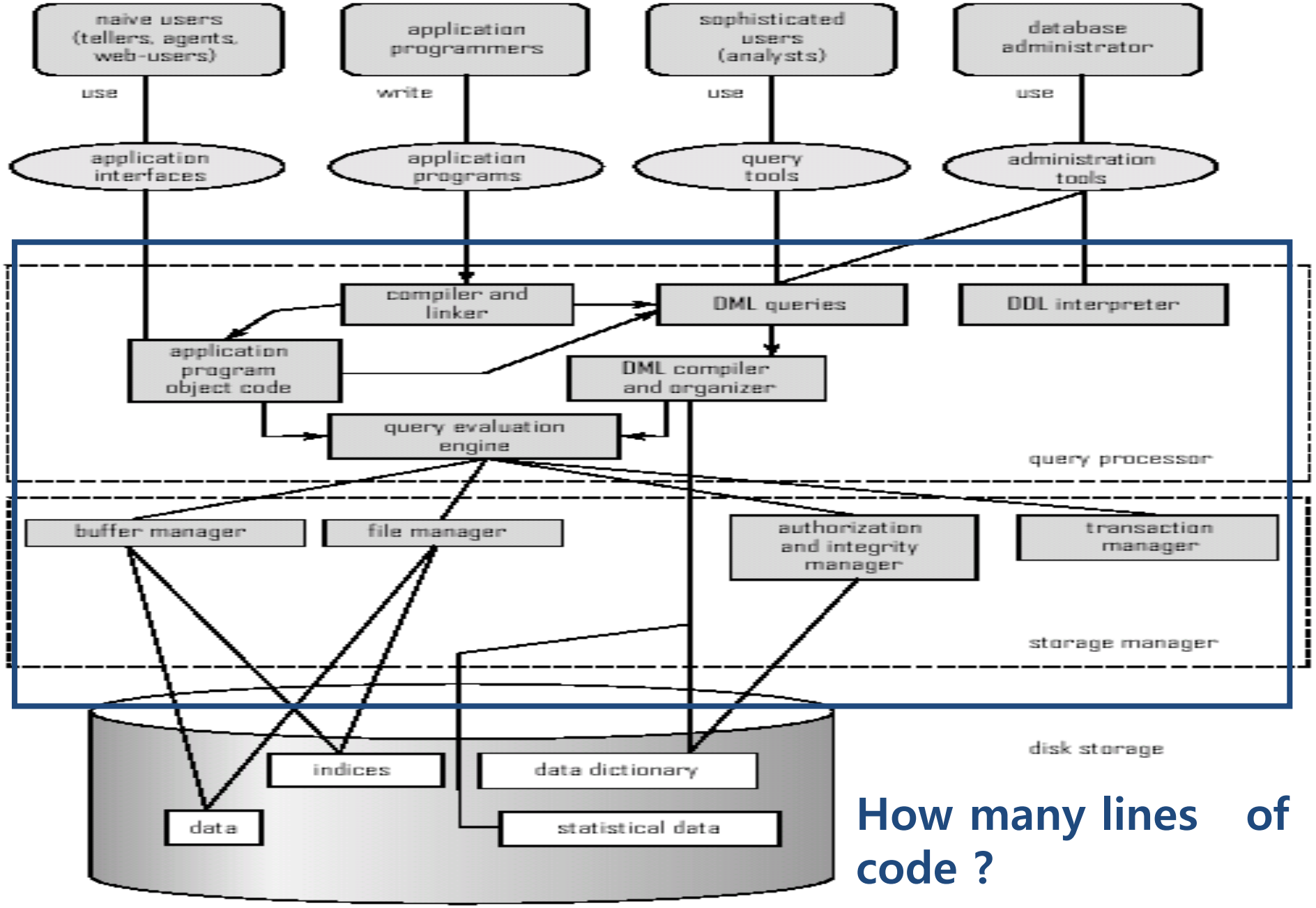
IBM
SQL/DS

1979 → 1982

Genealogy of Commercial DBMS Products



범용 "Disk-기반" DBMS Architecture



How many lines of code ?

Database Companies in the World

DBMS Market Share: World Wide (2011)

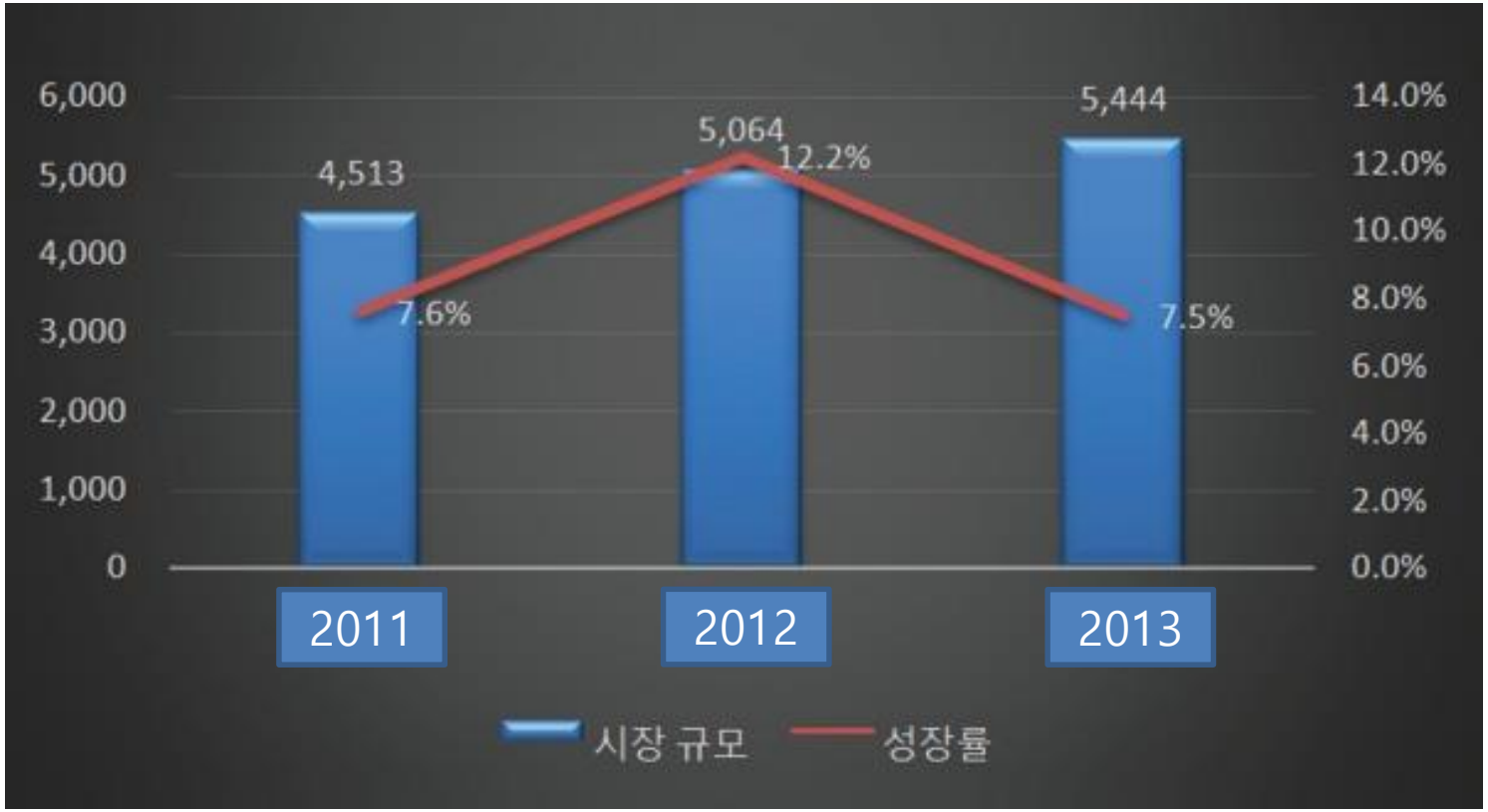
리서치 전문회사 가트너

2011년 매출기준 TOP 5 상용 관계형 데이터베이스 업체

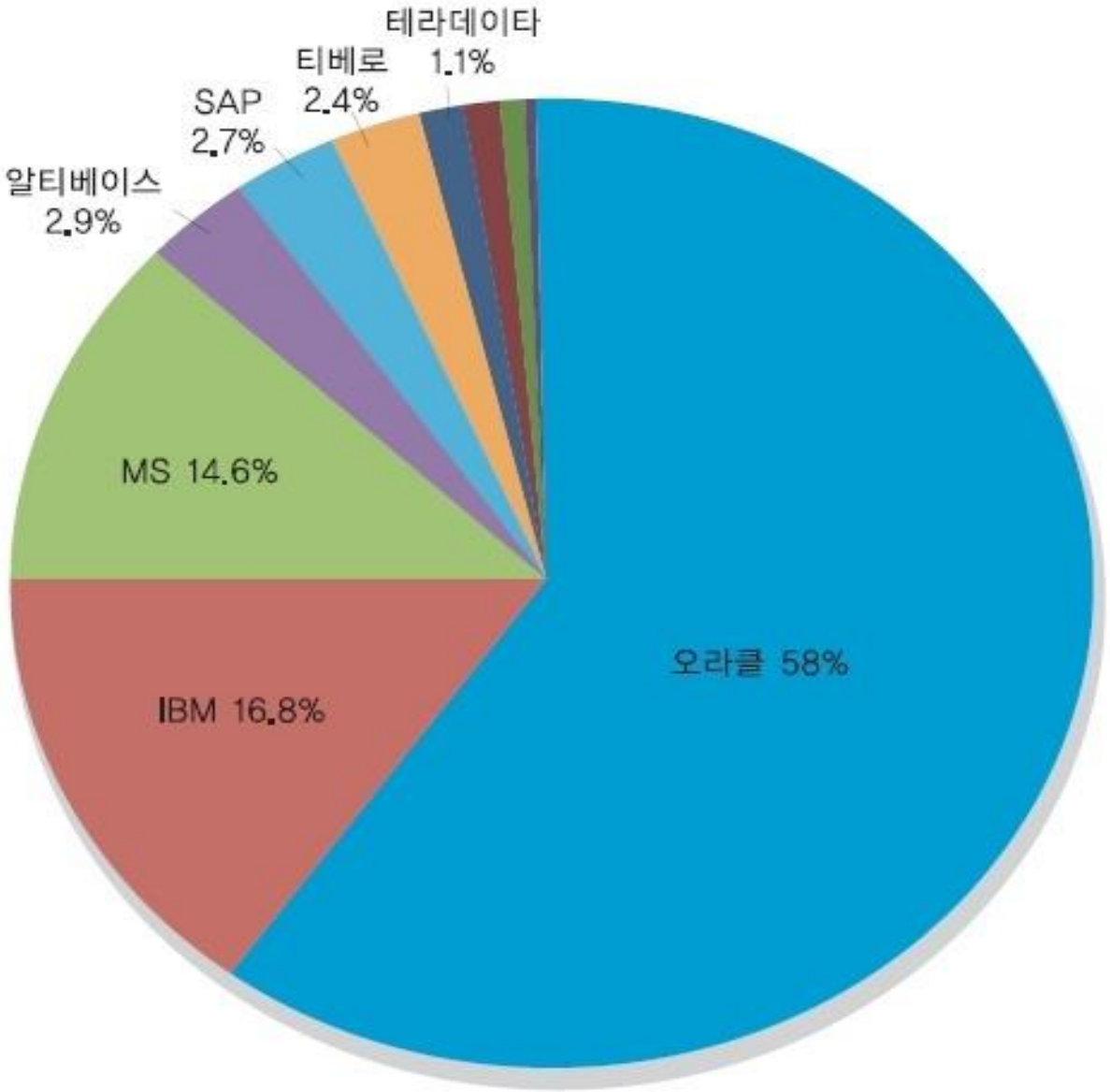
- Oracle (48.8%)
- IBM (20.2%)
- MicroSoft (17.0%)
- SAP (4.6%)
- TeraData (3.7%)

Source: Gartner Dataquest

국내 DBMS 시장규모 (5천억원 내외)



국내 DBMS Market Share (2013)



Lawrence Joseph Ellison (Oracle Founder)

- **Univ of Chicago, Physics Major**
- **1976년까지 캘리포니아의 중소기업에서 SW Programmer**
- **1977년 1200달러로 Oracle 창업**

  (Oracle: 신탁, 신의 뜻)
- **보유주식: 430억달러 (약 50조원)**
- **세계 부자순위 5위**

- **Oracle 현황**
  - **오라클 2014년도 매출 380억달러 (약 42조원)**
    - **DBMS, ERP, Data Warehouse, etc**
  - **고객: 미국CIA포함 전세계 27만개 기업**
  - **직원: 전세계 145개국에서 13만2천명**
  - **기업용 SW업체 중 1위, 종합 SW 업체 순위는 2위**

ORACLE

Oracle 성장 과정

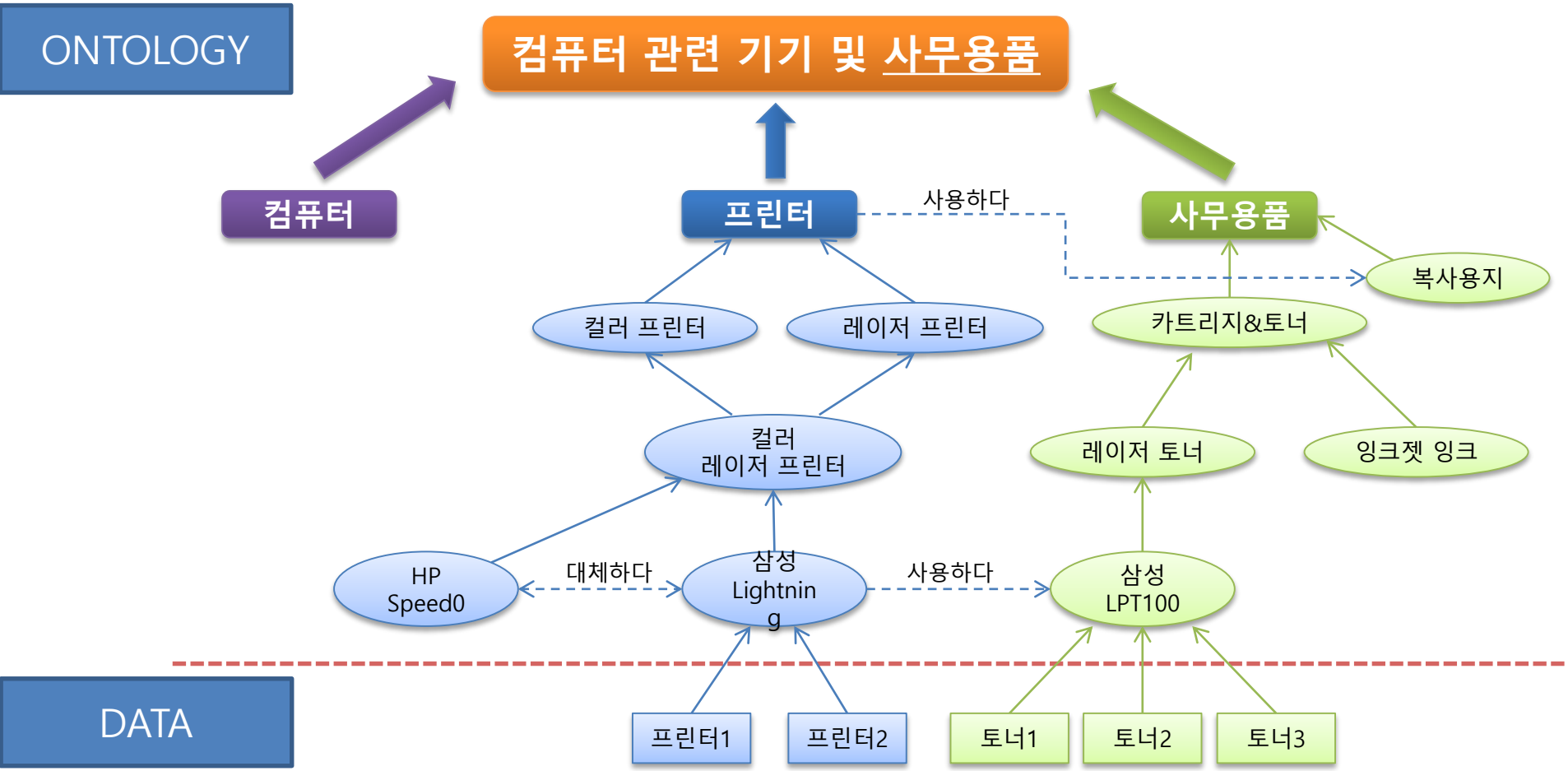
- **1970**년대말: **CIA**의 수집된 정보를 체계적 관리·분석해주는 프로젝트 성공
- **1980**년대: 관계형 **DBMS**의 시장점유에 선도적 역할
- **1990**년대: **Internet & E-Business** 열풍과 맞물려 또 한번 폭발적 성공
- **2000**년 이후: 기업용 **SW**의 모든 것을 공급하는 **One-Stop** 서비스 업체
- **2000**년 후반기: **200**억달러를 들여 무려 **27**개의 기업 **M&A**
- **2009**년 세계 4대 HW업체인 미국의 선마이크로시스템스를 $74억에 인수

최근 Database 기술의 주된 발전방향

- Intelligent Retrieval (지능형 검색)
- Large scale Processing (대규모검색, 빅데이터처리)

Ontology: 지식과 개념의 표현과 처리기술

- 컴퓨터 관련 기기 및 사무용품 온톨로지



Ontology Application: 신약개발분야

Ontology Applicable Example: Drug repositioning of Finsteride

FDA Approved @1997,
1mg / a day

탈모증

Alopecia

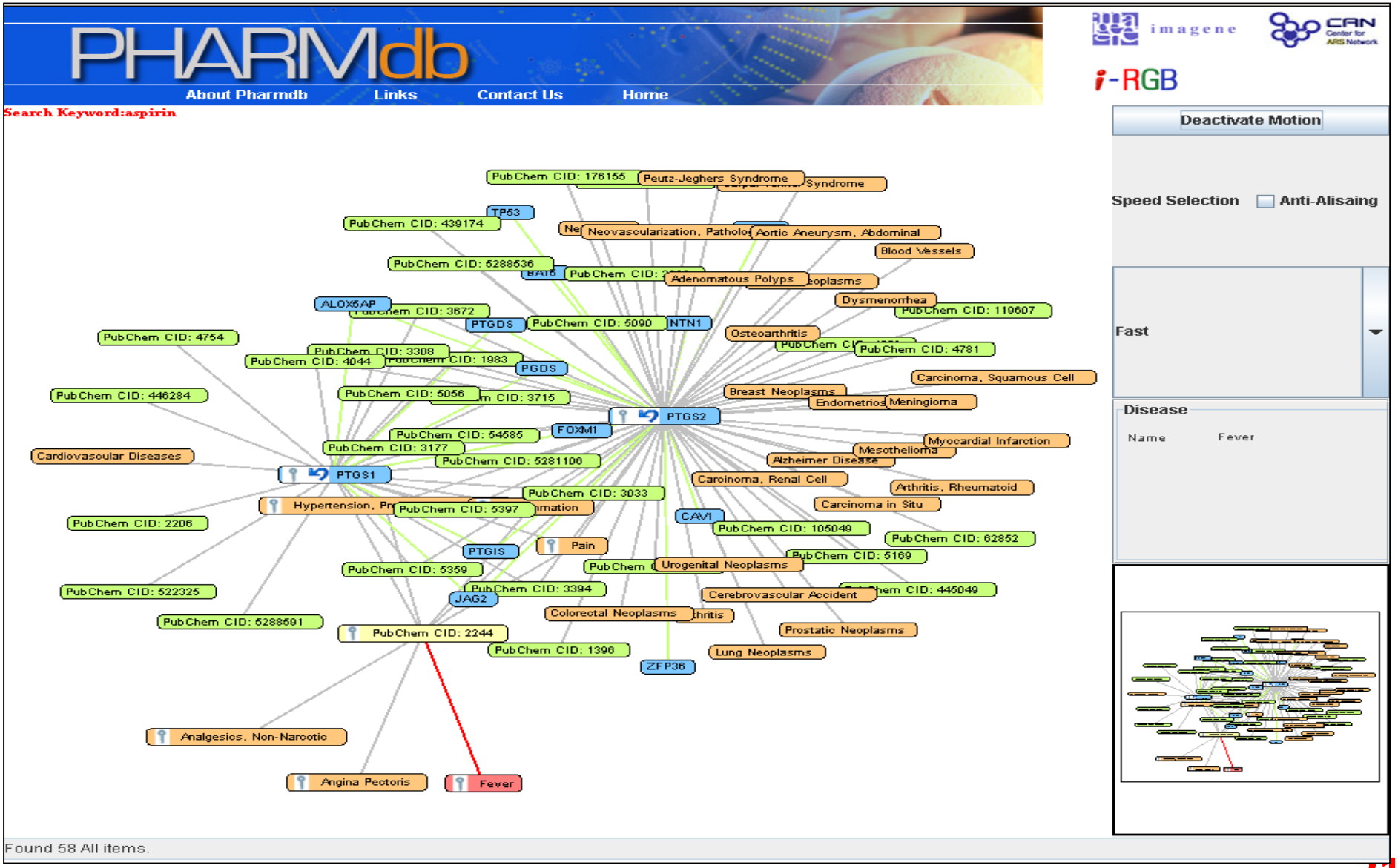
Finasteride

FDA Approved @1992,
5mg / a day

전립선비대증

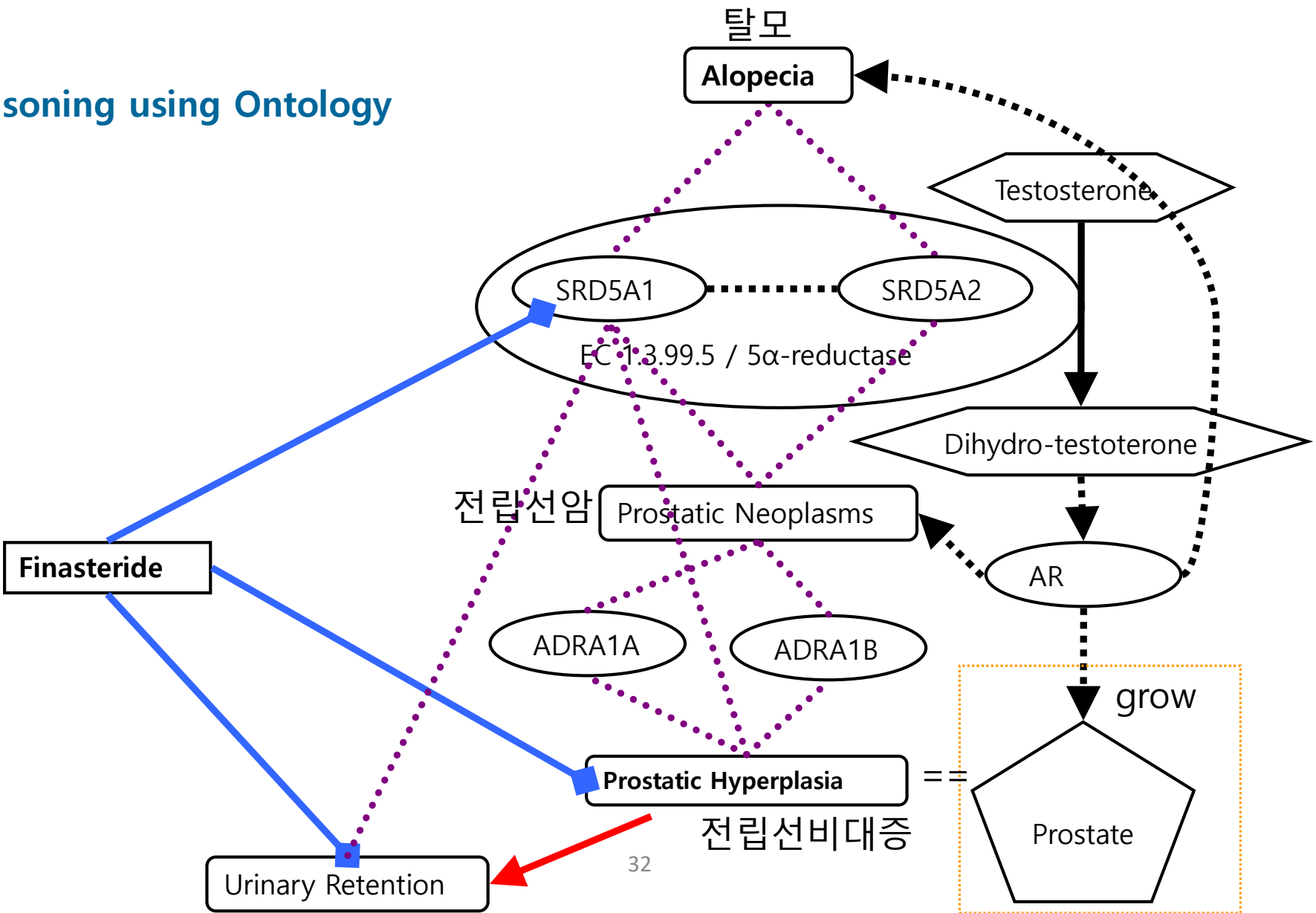
Prostatic Hyperplasia

Ontology Application: 신약개발분야



Ontology Application: 신약개발분야

Reasoning using Ontology



Large Scale Web Search

- Google server cluster
  - "less than $1,000" server for Error isolation, Easy to repair, Easy to scale
  - 450,000 servers (NYT estimate, Oct, 2006)
  - 900,000 servers (2011)
  - Maybe more than 1 million servers now (2015)!

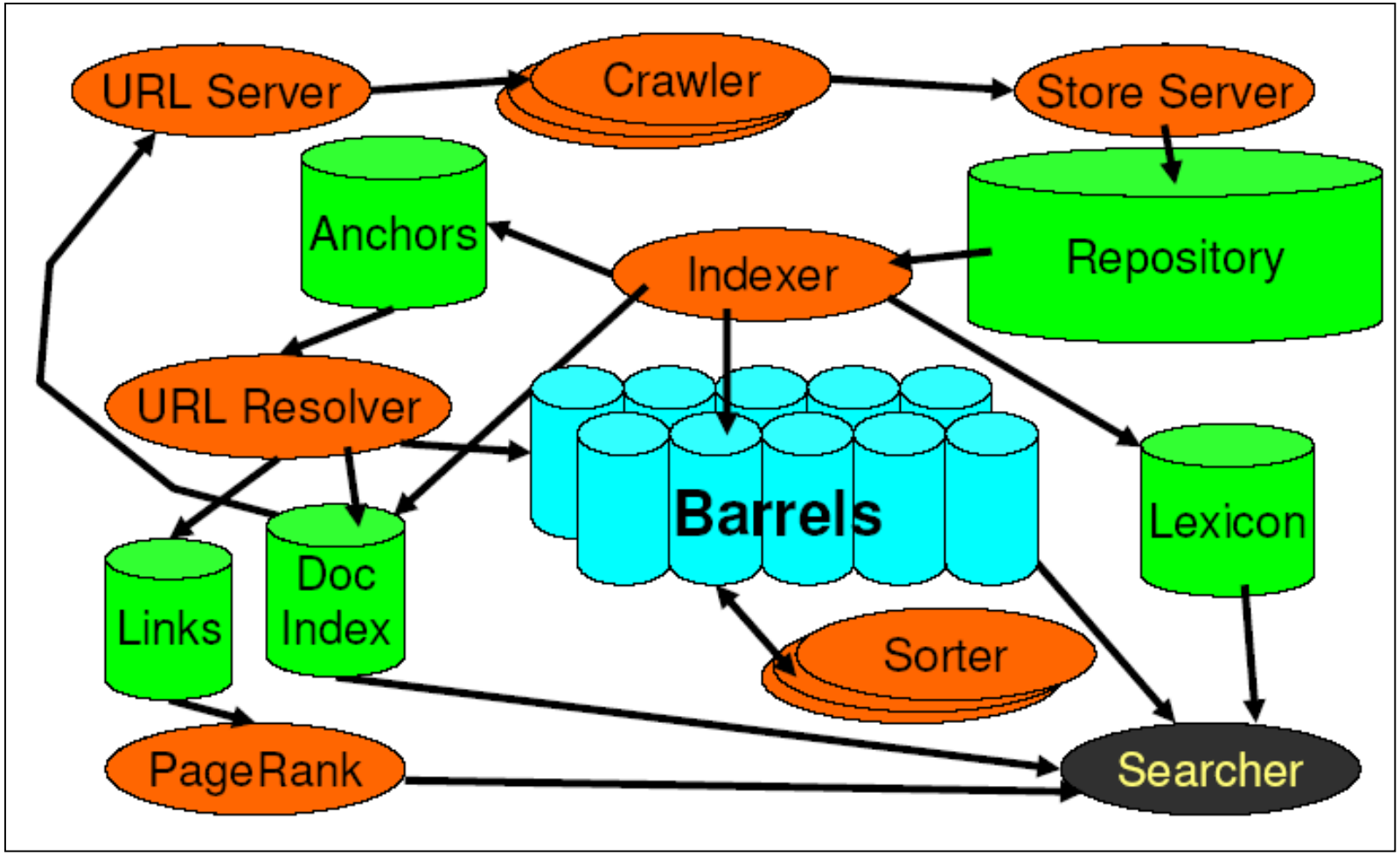
- Google's search index
  - Indexing most words in the WWW in the world
  - 100 million Giga bytes = 10^{17} bytes
  - Index Structure

```
potato:  (url_ZZ; 3, 101, 178, 2009); (url_pq; 1; 809); …
quake:   (url_ds; 1; 16);   (url_lk; 4; 3, 11, 12, 678); …
```

Figure 5.3 In Google's data center, Dalles, Oregon. A search engine's index is huge, because i*n principle* it keeps URLs for most of the words used on the Web; Google's index has been reported to be "100 million gigabytes" = 10^{17} bytes. However big it is, they can't store just one copy, because they need a backup in case some of those LEDs go dead.

Large Scale Web Search

** Google Search Engine Architecture



** Google Map-Reduce Framework! ➔ Big Data Processing

Big Data의 시대의 도래!

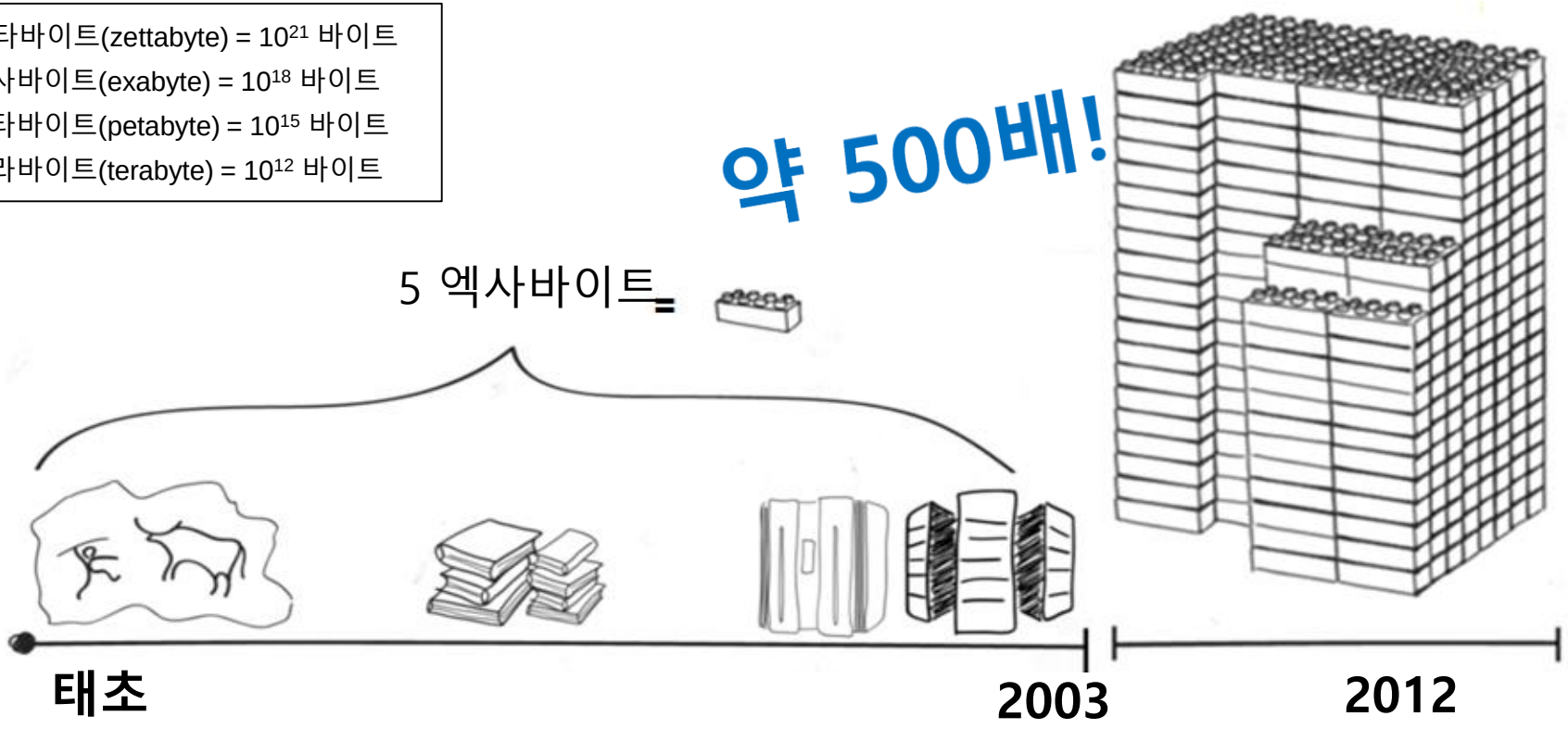
- 2012년 한 해동안 생성된 디지털 데이터

➔ 2,700,000,000,000,000,000,000 바이트 (2.7 ZB)

  - 원인: 정보화 가속, 모바일·소셜·센서 데이터의 급증
  - 1.5년마다 2배로 증가 ➔ 2020년엔 지금의 20배

2.7 제타바이트

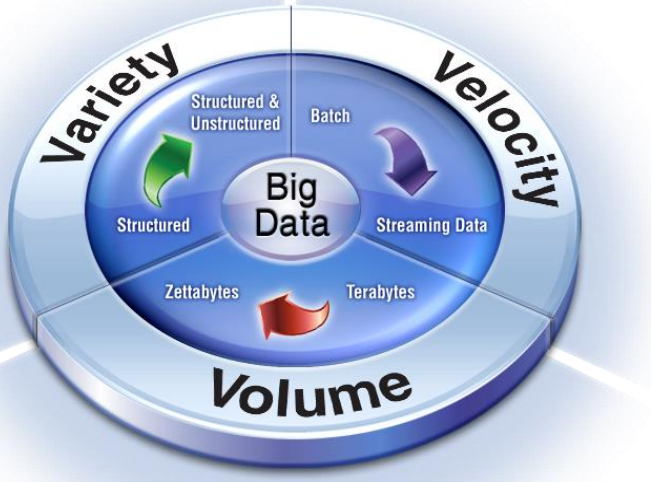
* 제타바이트(zettabyte) = 10^{21} 바이트
엑사바이트(exabyte) = 10^{18} 바이트
페타바이트(petabyte) = 10^{15} 바이트
테라바이트(terabyte) = 10^{12} 바이트



Big Data 101: How Big Data Makes Big Impacts, Intel
http://www.intel.com/content/www/us/en/big-data/big-data-101-animation.html

Big Data의 특징

- "빅 데이터"의 속성: **3V** 또는 **4V**
  - 크기(Volume)
  - 속도(Velocity)
  - 다양성(Variety)
  - 가치(Value)



3V

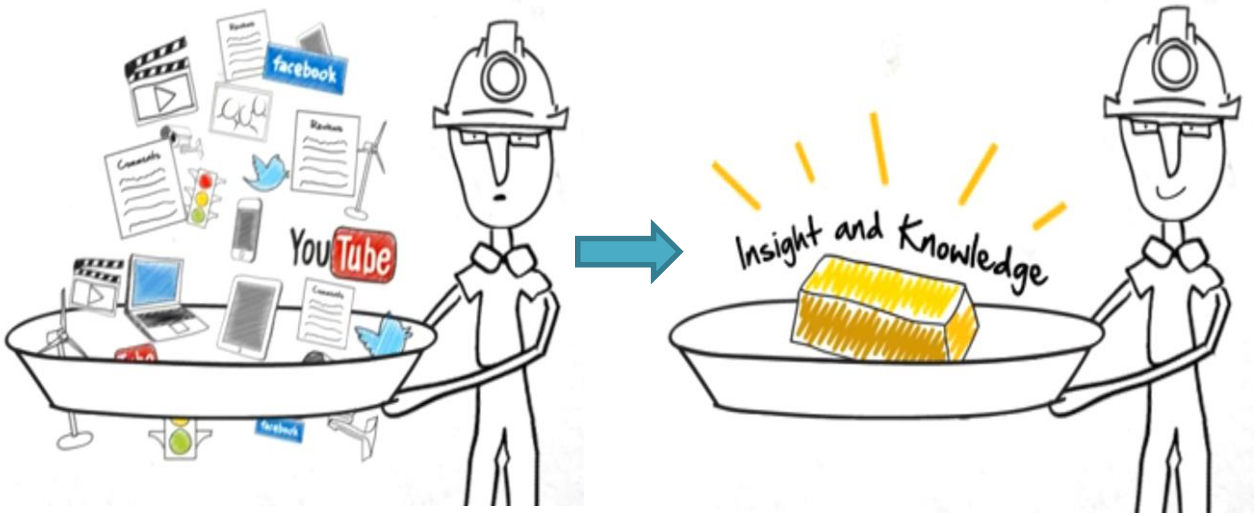
– Gartner –

The 4th V

– Oracle –

Big Data가 주는 가치

- 데이터: **의미를 담고 있는** 기록된 사실 [Elmasri and Navathe. Fundamentals of Database Systems]
- 그렇다면, 다양하고 많은 "빅 데이터" ➔ 다양하고 많은 의미?
  - "빅 데이터"를 처리, 분석하여 의미를 제대로 찾아낼 때에만!



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http://www.intel.com/content/www/us/en/big-data/big-data-101-animation.html

기계화/자동화 ➔ 제조 프로세스 혁신
빅 데이터 분석 ➔ 판단 프로세스 혁신

MapReduce란?

- **구글(Google)**이 대용량 Web Data처리를 위한 분산 처리 프레임워크
  - 큰 작업을 잘게 **나누고(Map)** 종류별로 **모아서(Reduce)** 처리하는 방식
  - MapReduce는 비공개된 Google의 SW
  - 2004년에 논문을 통해 세상에 알려짐

- MapReduce가 널리 쓰이게 된 이유는? **Hadoop의 등장**

  - Hadoop: 구글의 공식 허가를 받은 MapReduce의 오픈 소스 버전
    몇몇 회사는 자체 프레임워크 사용 → 개발 및 유지보수 비용 부담
  - 2006년 초: Don Cutting이 Yahoo!에서 Apache Hadoop 프로젝트

* Hadoop은 Cutting의 아들이 좋아하는 코끼리 장난감 이름

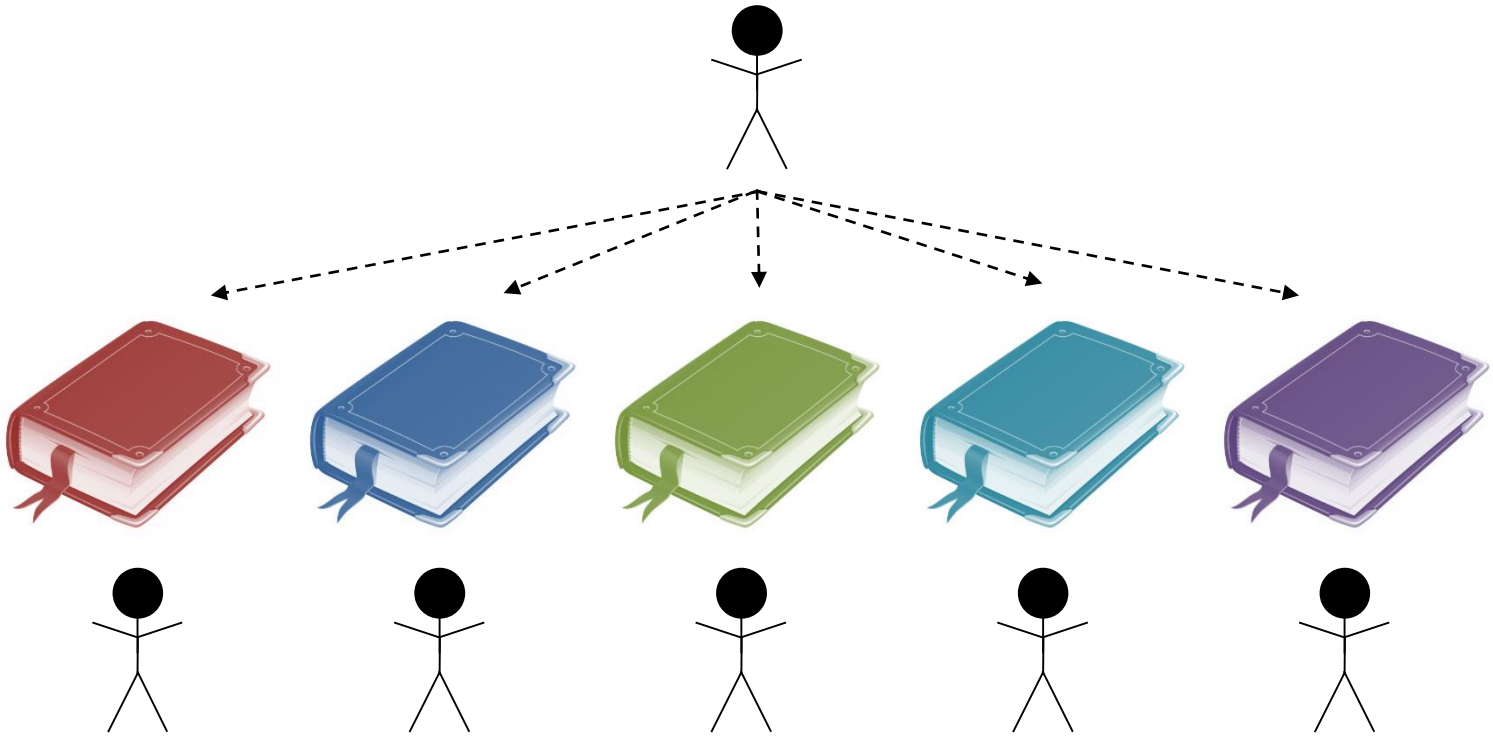
MapReduce 예제: 단어 세기

- 임무: 아래 책들에서 각 단어가 몇 번 나오는지 세어주세요.

- 문제점: 양이 너무 많아서 혼자 세면 너무 오래 걸림
- 해결방법: 여럿이서 나누어 하기
  - 여럿에게 일을 **나누어서** 시키고 (Map)
  - 몇 명이 각 결과를 **모아서** 작업을 완료 (Reduce)

MapReduce 예제: 단어 세기 – Map 단계

- Map: 조금씩 **나누어서** 일 시키기



책상 1
사과 1
word 1
사과 1

책상 1
배 1
book 1

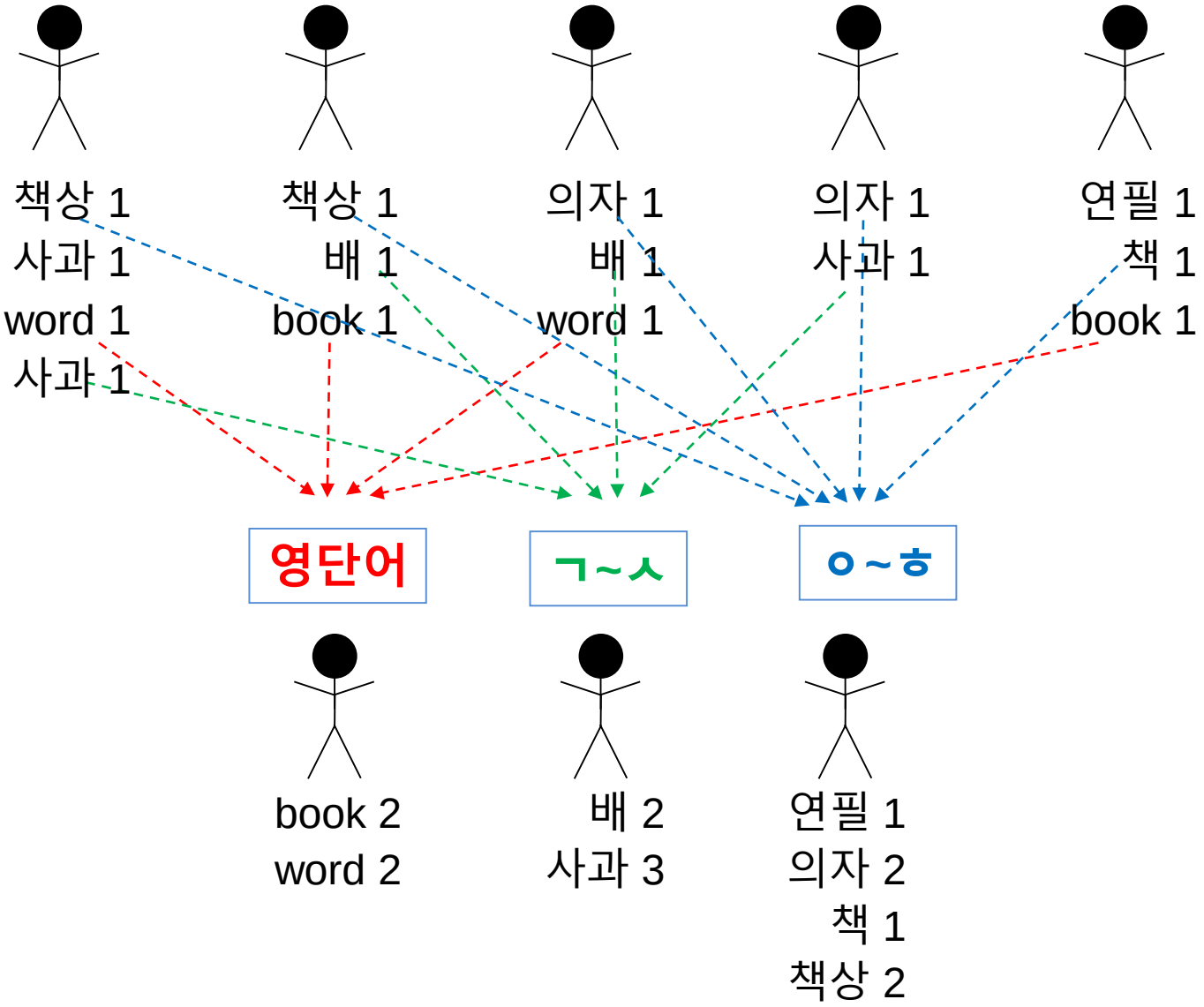
의자 1
배 1
word 1

의자 1
사과 1

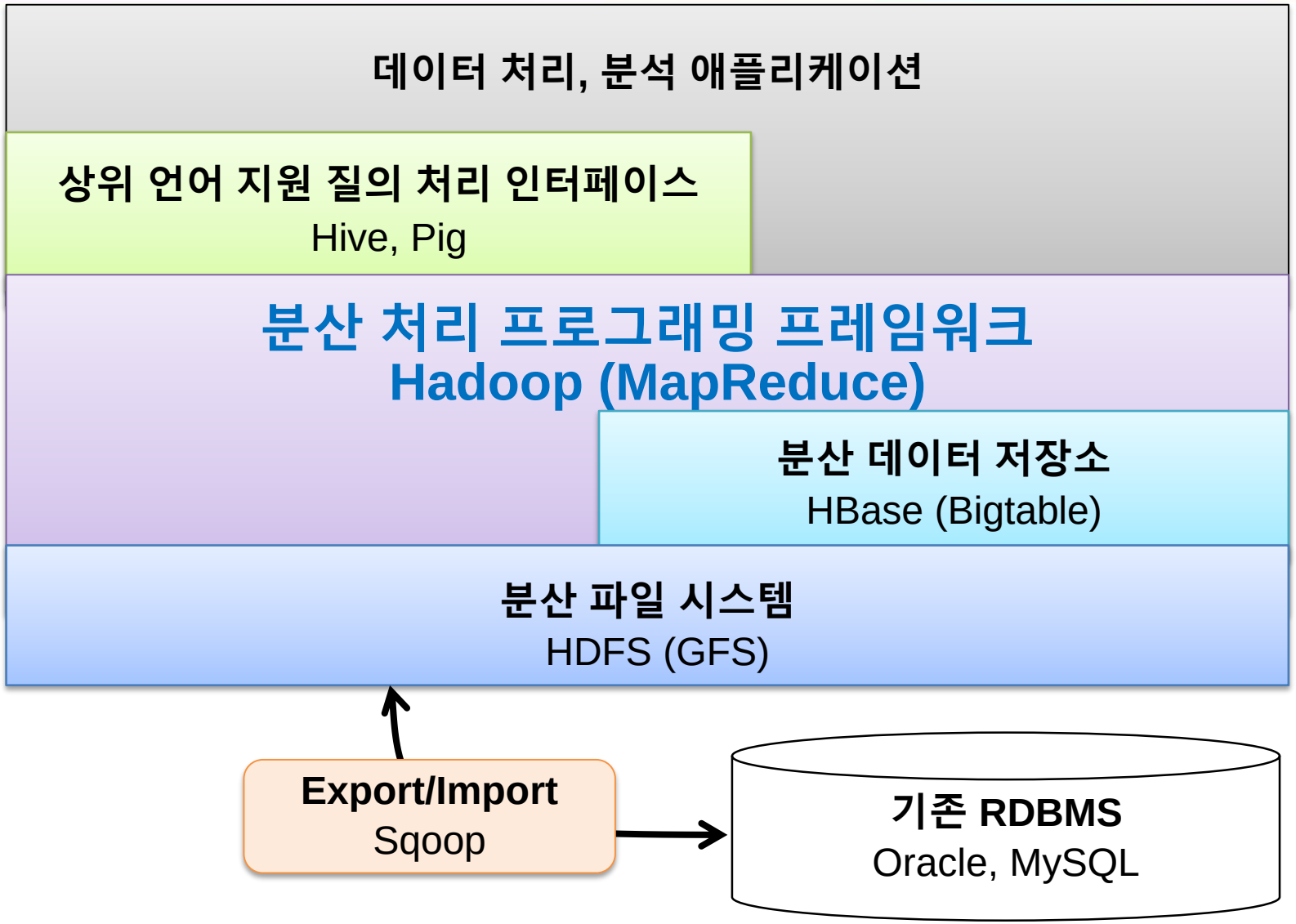
연필 1
책 1
book 1

MapReduce 예제: 단어 세기 – Reduce 단계

- Reduce: 몇 명이 각 결과를 **모으기**



Hadoop 관련 시스템 구조



Database System Concepts