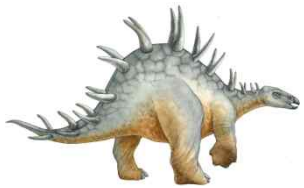
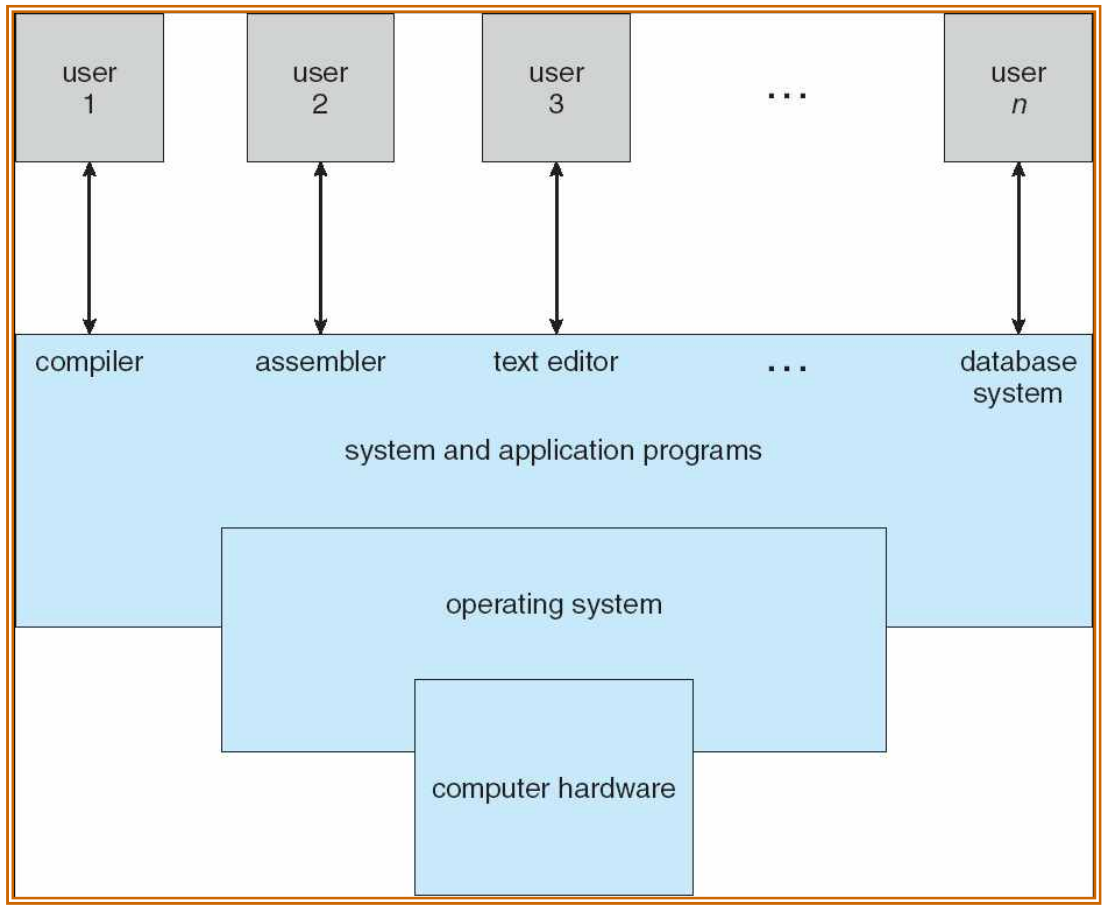
Chapter 1: Introduction

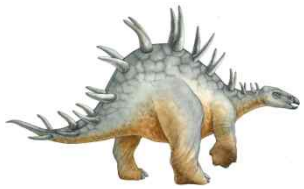
Operating System이란?

- computer hardware와 computer user 사이의 중재자 역할을 수행하는 프로그램
  - The job of the OS is to adapt to hardware. Examples: MS-DOS/Windows, MacOS, Unix, and many more
- Operating system goals:
  - Execute user programs and make solving user problems easier.
  - Make the computer system convenient to use.



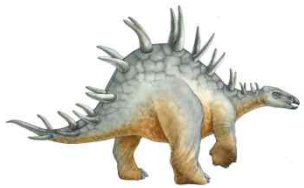
Abstract View of System Components





Computer System Components

- Computer system의 네가지 구성요소
  - Hardware –basic computing resources를 제공
    - CPU, memory, I/O devices
  - Operating system
    - 다양한 응용과 사용자들간의 하드웨어 사용을 Controls하고 coordinates 함
  - Application programs
    - 사용자의 계산 문제를 풀기 위해 시스템 자원이 어떻게 사용될지를 정의
    - Word processors, compilers, web browsers, database systems, video games
  - Users
    - People, machines, other computers



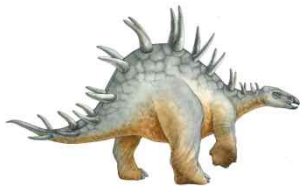
Operating System Definitions

- 운영체제의 정의

- OS is a resource allocator
  - Manages all resources
  - Decides between conflicting requests for efficient and fair resource use

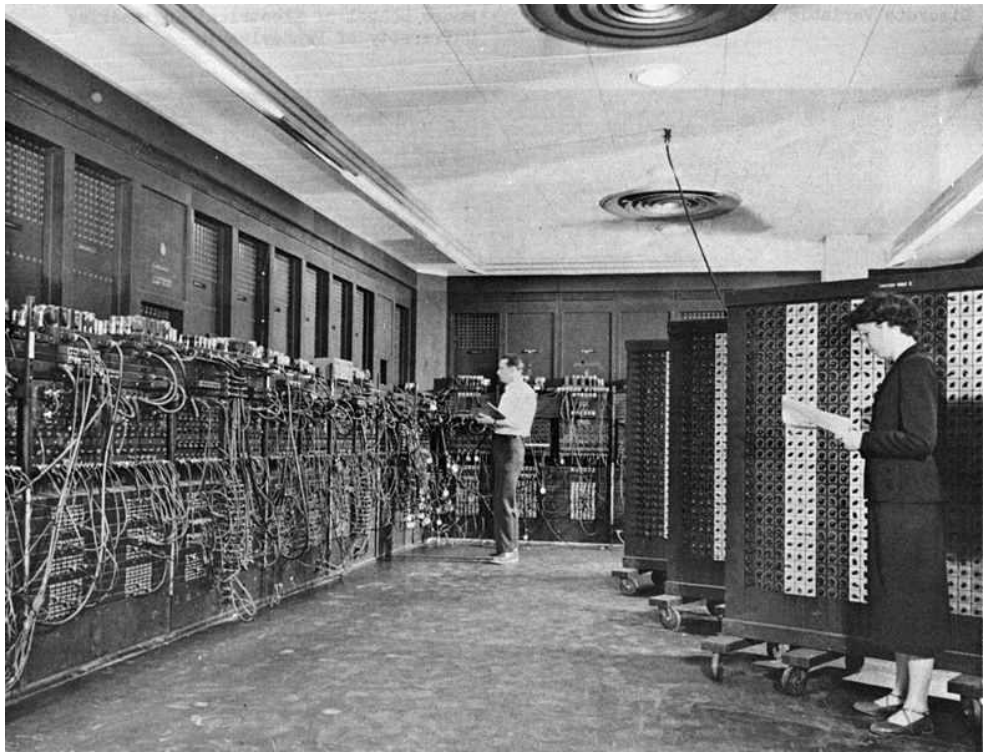
- OS is a control program
  - Controls execution of programs to prevent errors and improper use of the computer

최초의 컴퓨터는?



OS History – ENIAC의 프로그래밍과 OS?

- 최초의 다목적 컴퓨터(ENIAC)에서 프로그래밍은?
  - 1946-1955
  - 10진수 내장 프로그래밍

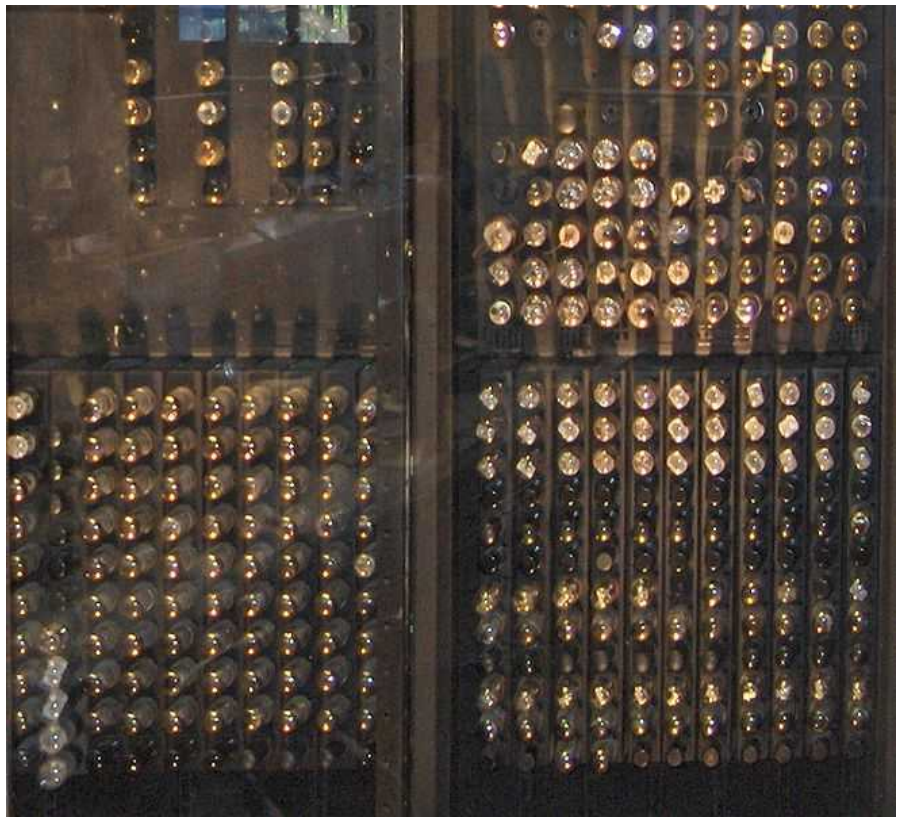


Glen Beck (background) and Betty Snyder (foreground) program the ENIAC in BRL building 328

http://en.wikipedia.org/wiki/ENIAC

OS History – ENIAC의 프로그래밍과 OS?

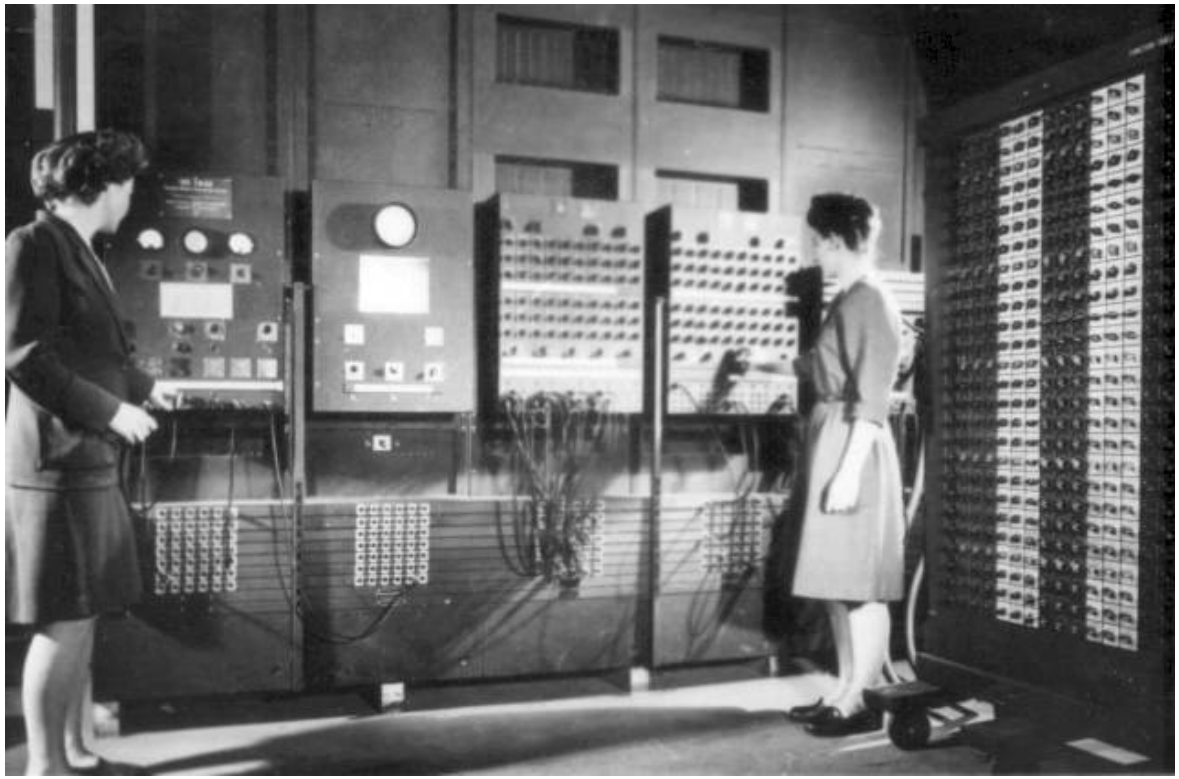
Irwin Goldstein (foreground) sets the switches on one of the ENIAC's function tables at the Moore School of Electrical Engineering



Detail of the back of a panel of ENIAC, showing vacuum tubes.

OS History – ENIAC의 프로그래밍과 OS?

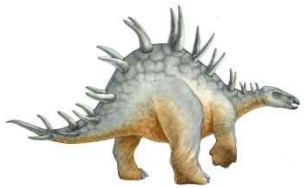
- 최초의 다목적 컴퓨터에서 Operating 은?



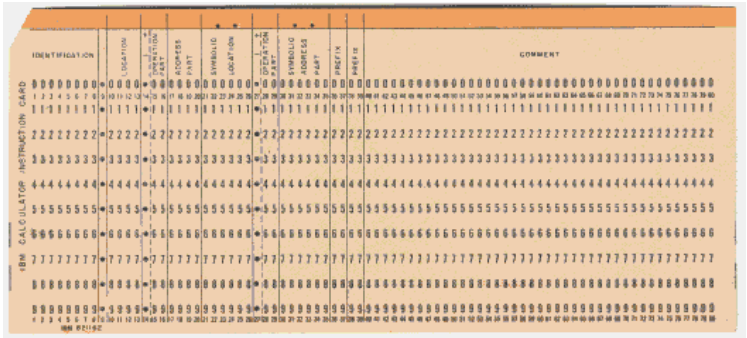
Two women operating the ENIAC's main control panel while the machine was still located at the Moore School

OS History

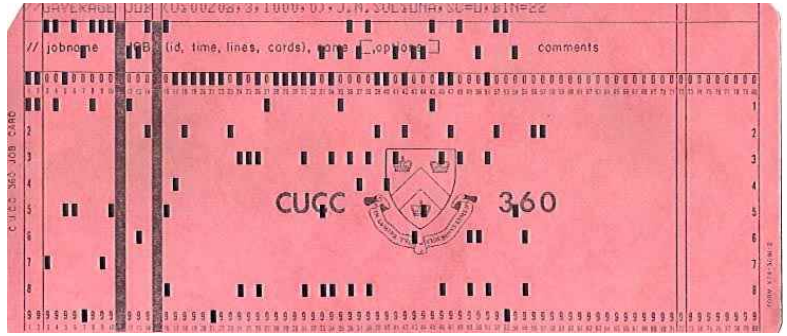
- Batch System(일괄처리 시스템)
- Multi-programming System(다중 프로그래밍 시스템)
- Time Sharing System(시분할 시스템)
- etc
  - Real-time System
  - Multi-Processing System
  - Distributed System



OS History-Batch System



Punch Card의 예



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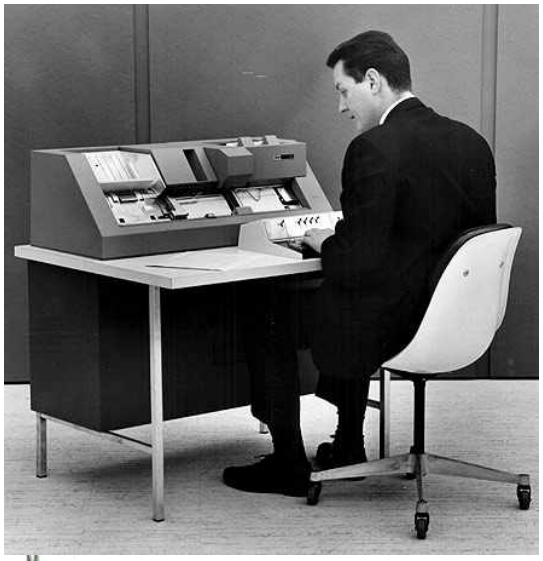
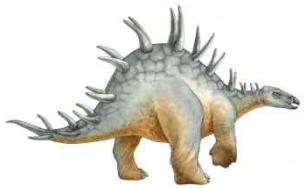


Punch Card 작업을 하는 사람(IBM)

Punch Card 입력 컴퓨터(IBM)

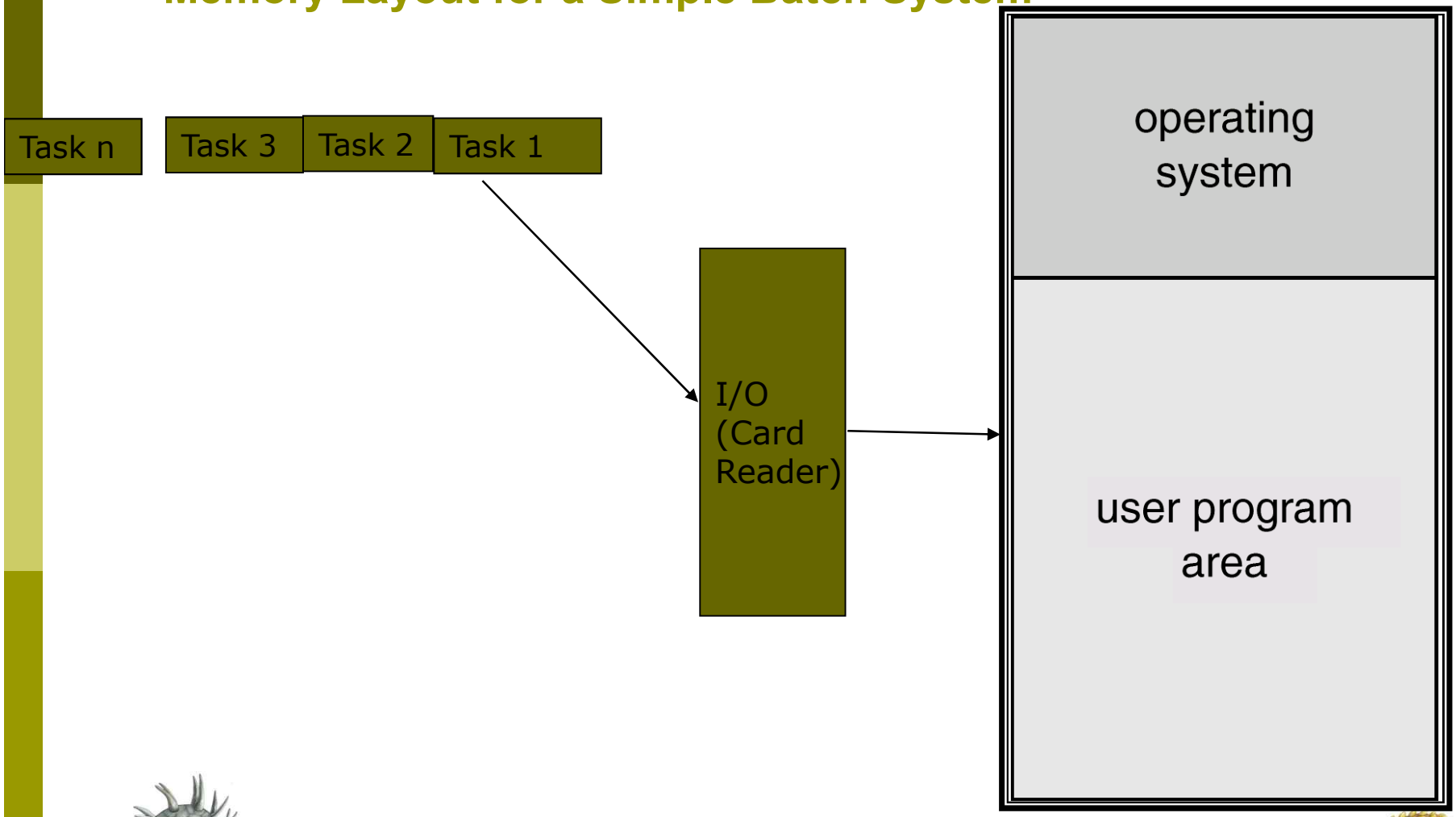
OS History-Batch System

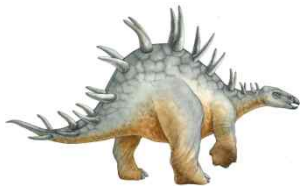
- Reduce setup time by batching similar jobs
- Automatic job sequencing – automatically transfers control from one job to another. First rudimentary operating system.
  - 예)CPU와 I/O간(Card Reader)의 처리속도 차이 존재
    - CPU : 초당 수천개
    - Card Reader : 초당 20장(분당 1200장)
- Resident monitor
  - initial control in monitor
  - control transfers to job
  - when job completes control transfers pack to monitor



OS History - Batch System

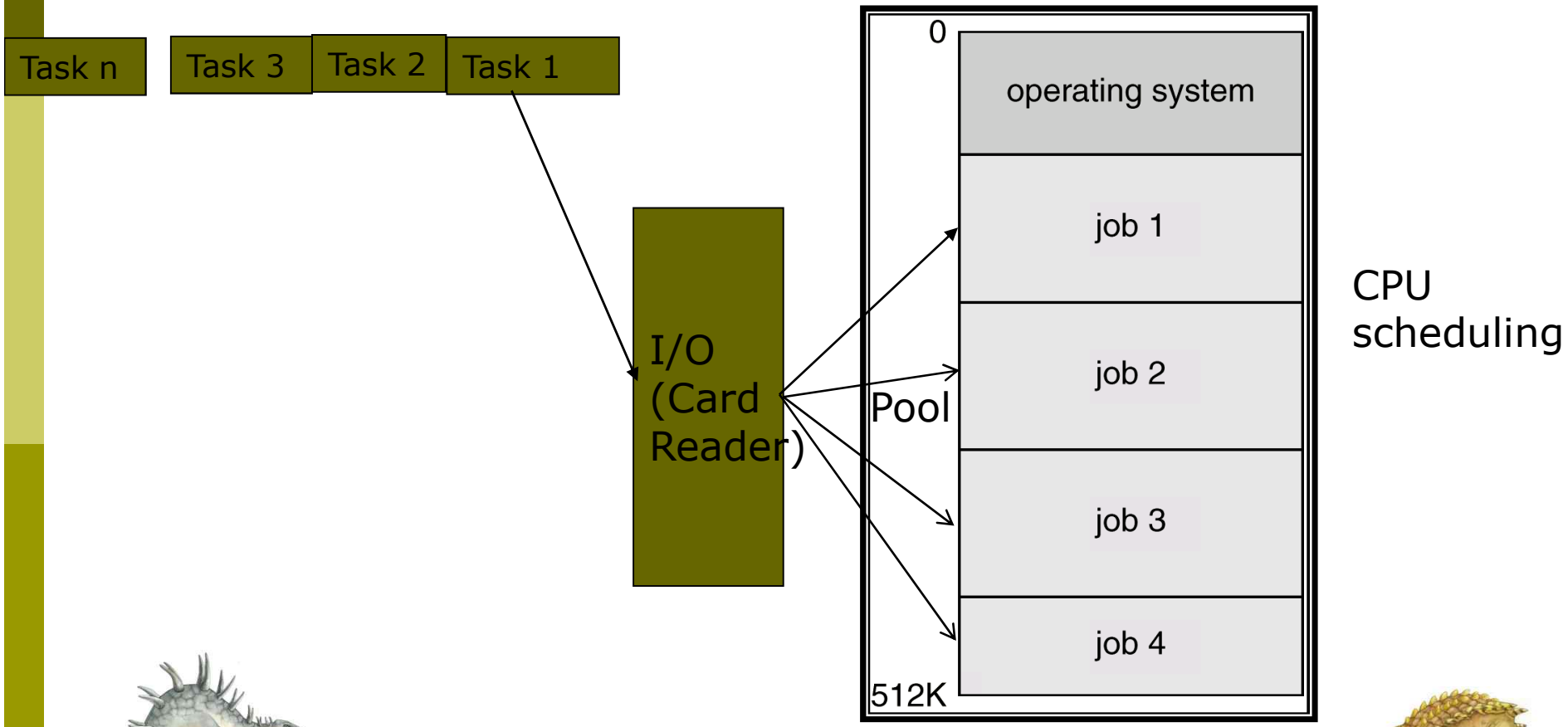
Memory Layout for a Simple Batch System

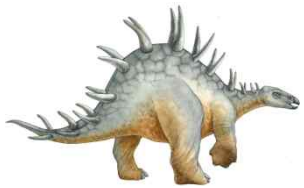




OS History – Multiprogrammed Systems

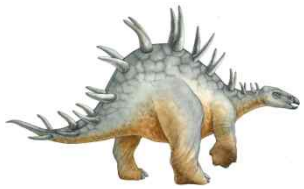
Several jobs are kept in main memory at the same time, and the CPU is multiplexed among them.





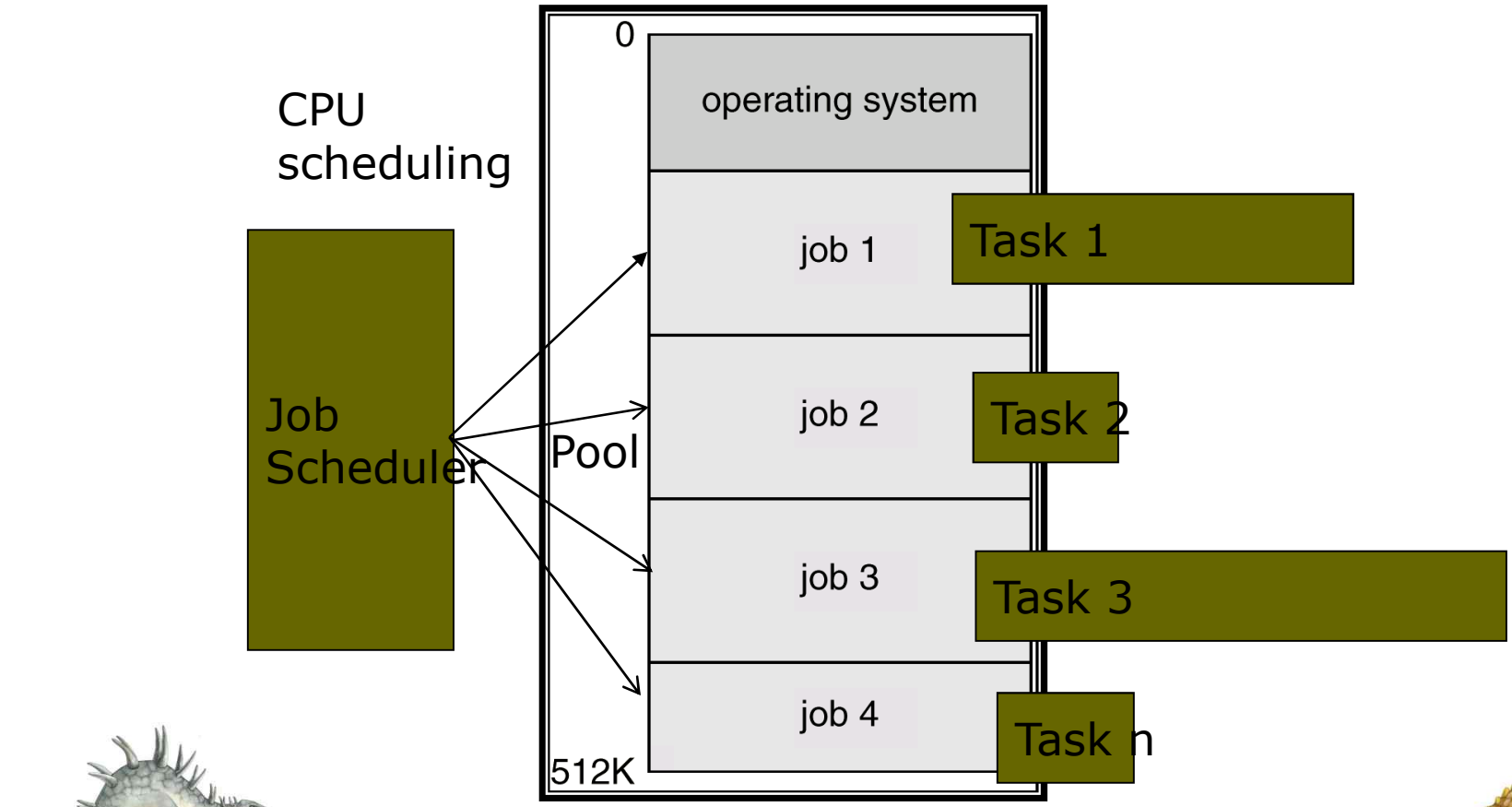
OS History – Multiprogrammed Systems

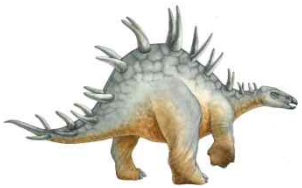
- OS Features Needed for Multiprogramming
  - I/O routine supplied by the system.
  - Memory management
    - the system must allocate the memory to several jobs.
  - CPU scheduling
    - the system must choose among several jobs ready to run.
  - Allocation of devices.



OS History - Time-Sharing Systems

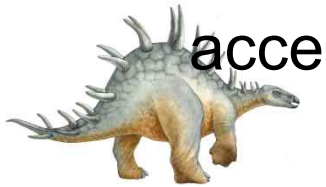
Minimize Response Time!





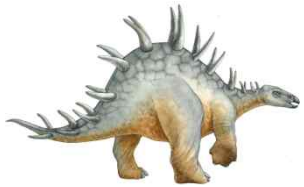
Time-Sharing Systems–Interactive Computing

- The CPU is multiplexed among several jobs that are kept in memory and on disk (the CPU is allocated to a job only if the job is in memory).
- A job swapped in and out of memory to the disk.
  - Swap-In
  - Swap-Out
- On-line communication between the user and the system is provided;
  - when the operating system finishes the execution of one command, it seeks the next "control statement" from the user's keyboard.
- On-line system must be available for users to access data and code.



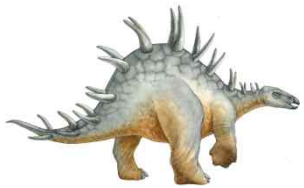
Desktop Systems

- *Personal computers* – computer system dedicated to a single user.
- I/O devices – keyboards, mice, display screens, small printers.
- User convenience and responsiveness.
- Can adopt technology developed for larger operating system' often individuals have sole use of computer and do not need advanced CPU utilization of protection features.
- May run several different types of operating systems (Windows, MacOS, UNIX, Linux)



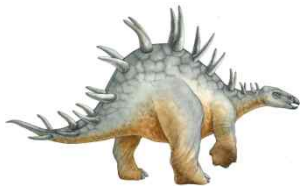
Parallel Systems

- Multiprocessor systems with more than on CPU in close communication.
- *Tightly coupled system* – processors share memory and a clock; communication usually takes place through the shared memory.
- Advantages of parallel system:
  - Increased *throughput*
  - Economical
  - Increased reliability
    - graceful degradation
    - fail-soft systems

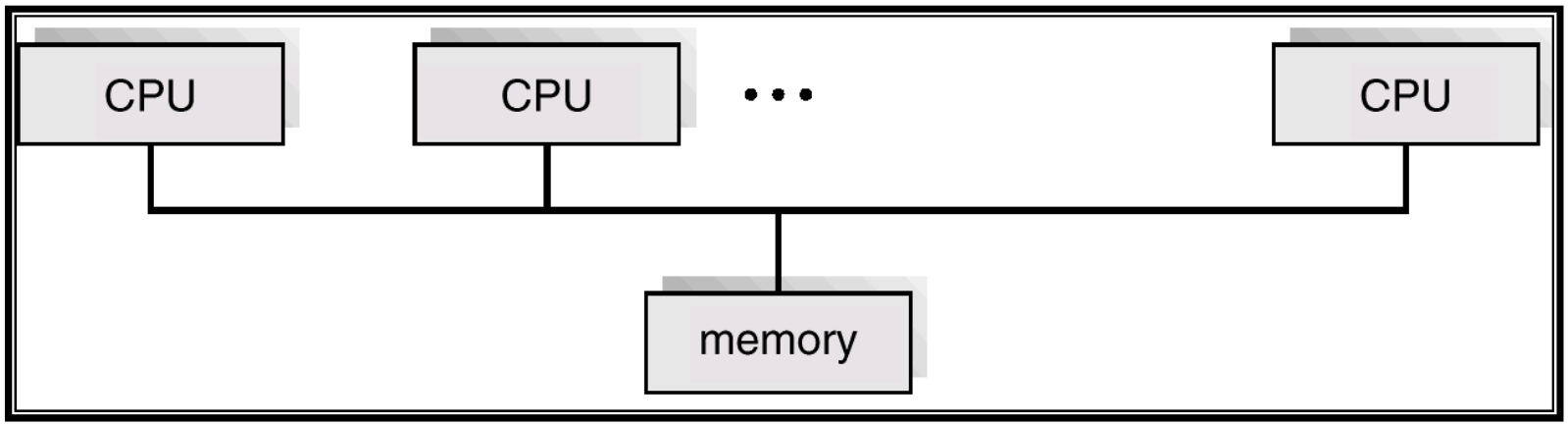


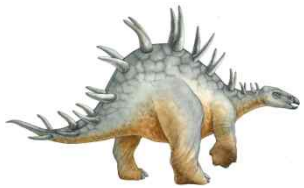
Parallel Systems (Cont.)

- *Symmetric multiprocessing (SMP)*
  - Each processor runs and identical copy of the operating system.
  - Many processes can run at once without performance deterioration.
  - Most modern operating systems support SMP
- *Asymmetric multiprocessing*
  - Each processor is assigned a specific task; master processor schedules and allocated work to slave processors.
  - More common in extremely large systems



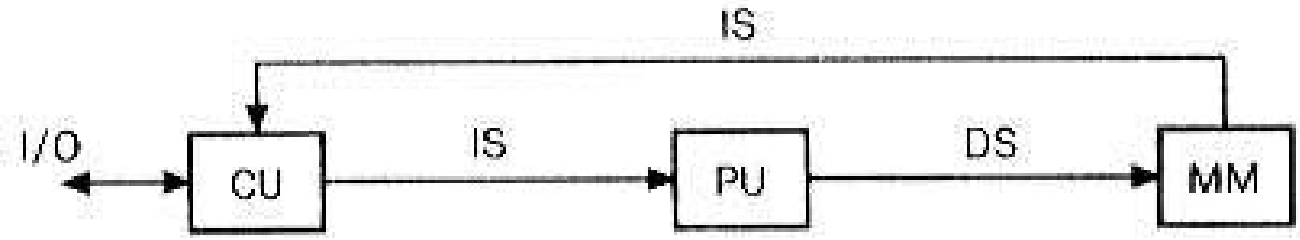
Symmetric Multiprocessing Architecture



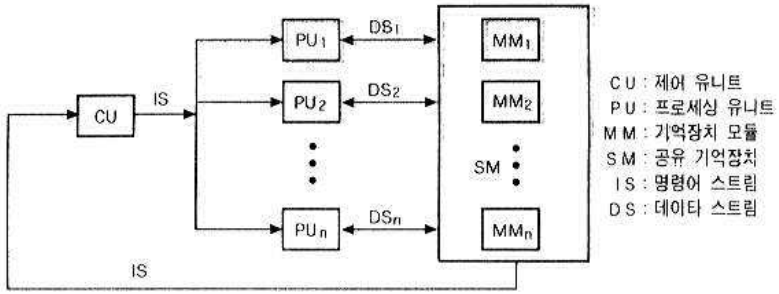


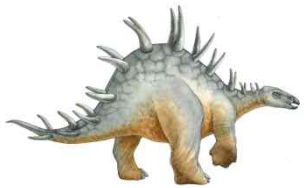
대칭적 다중처리(SMP : Symmetric Multiprocessing)

- 컴퓨터 시스템의 분류 (by Flynn)
  - Single Instruction Single Data (SISD) stream
    - 단일 처리기가 한 메모리에 저장된 데이터를 처리하기 위해 단일 명령 스트림을 수행



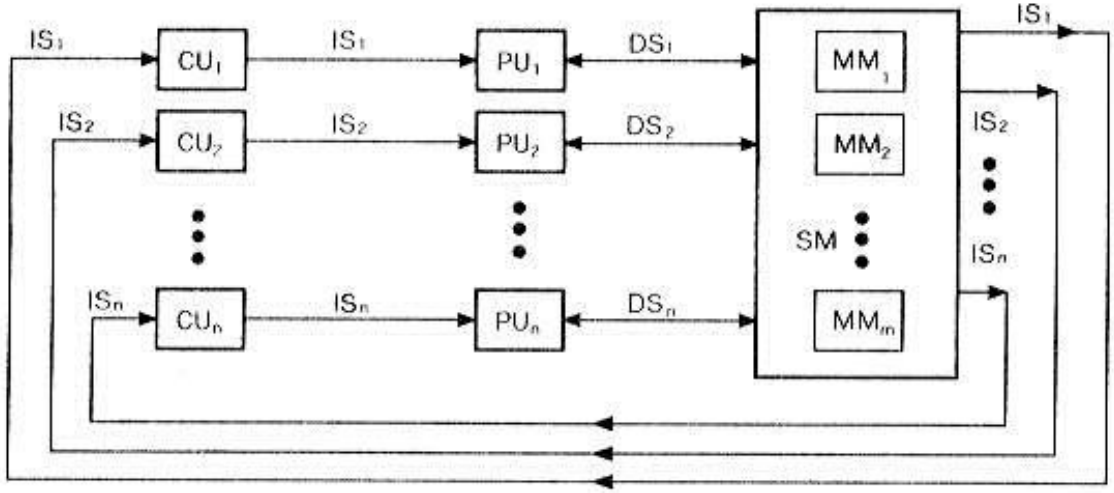
  - Single Instruction Multiple Data (SIMD) stream
    - 각 (동일) 명령이 서로 다른 데이터 집합에 대하여 서로 다른 처리기에 의해 수행
    - 벡터 및 배열 처리기 (vector and array processors)
    - Pentium 처리기의 superscalar 구조

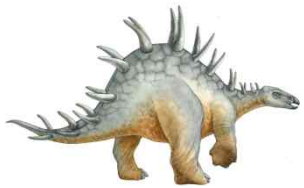




대칭적 다중처리 (계속)

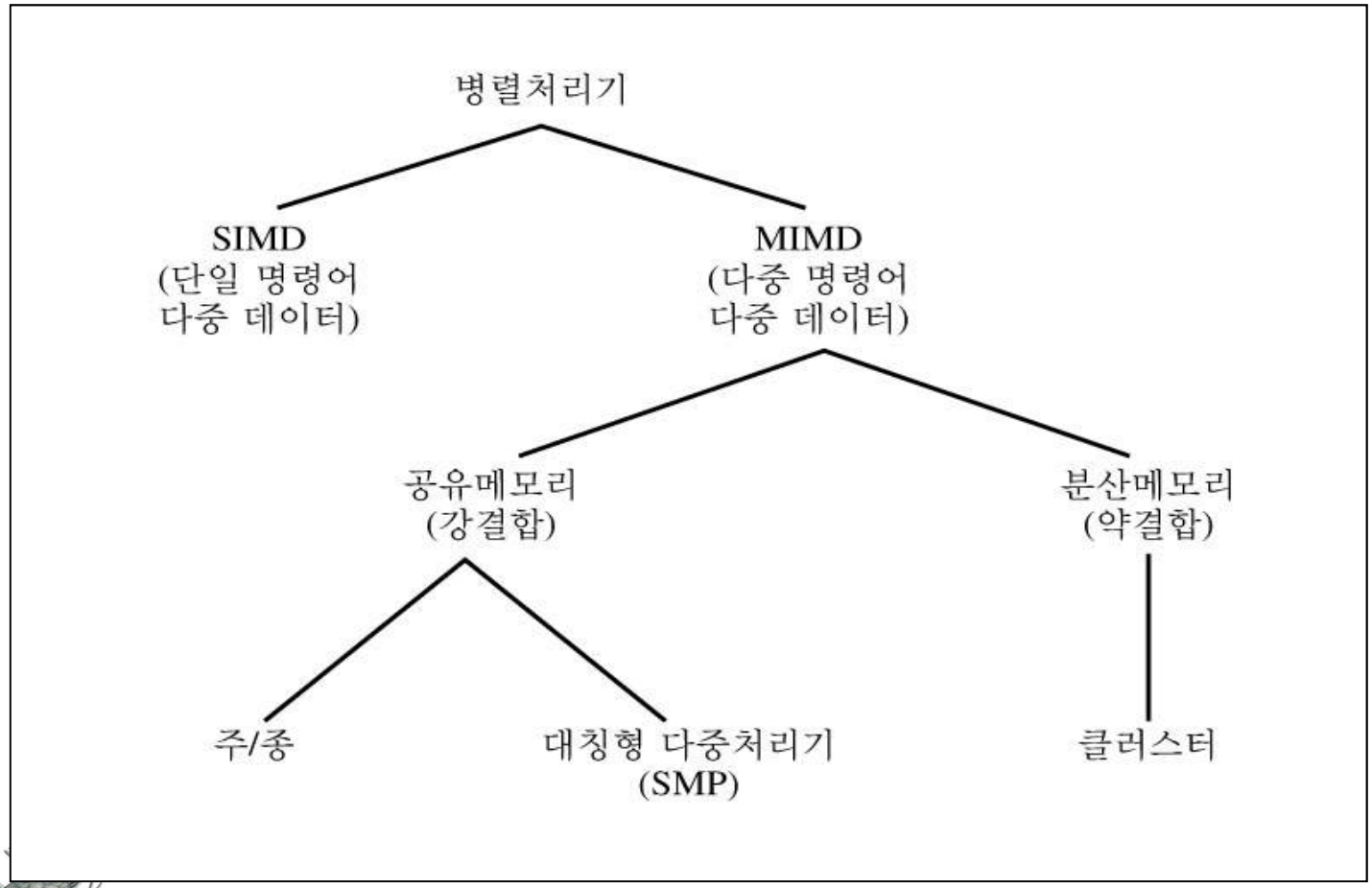
- 컴퓨터 시스템의 분류 (by Flynn) (계속)
  - Multiple Instruction Single Data (MISD) stream
    - (같은) 일련의 데이터가 처리기들의 집합에 전송되고, 각 처리기는 서로 다른 명령을 수행
    - 지금까지 구현된 적이 없음
  - Multiple Instruction Multiple Data (MIMD) stream
    - 다수의 처리기가 서로 다른 데이터 집합에 대하여 서로 다른 일련의 명령어들을 동시에 수행

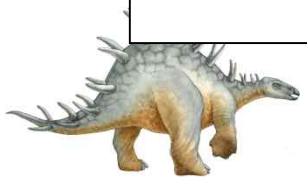




대칭적 다중처리 (계속)

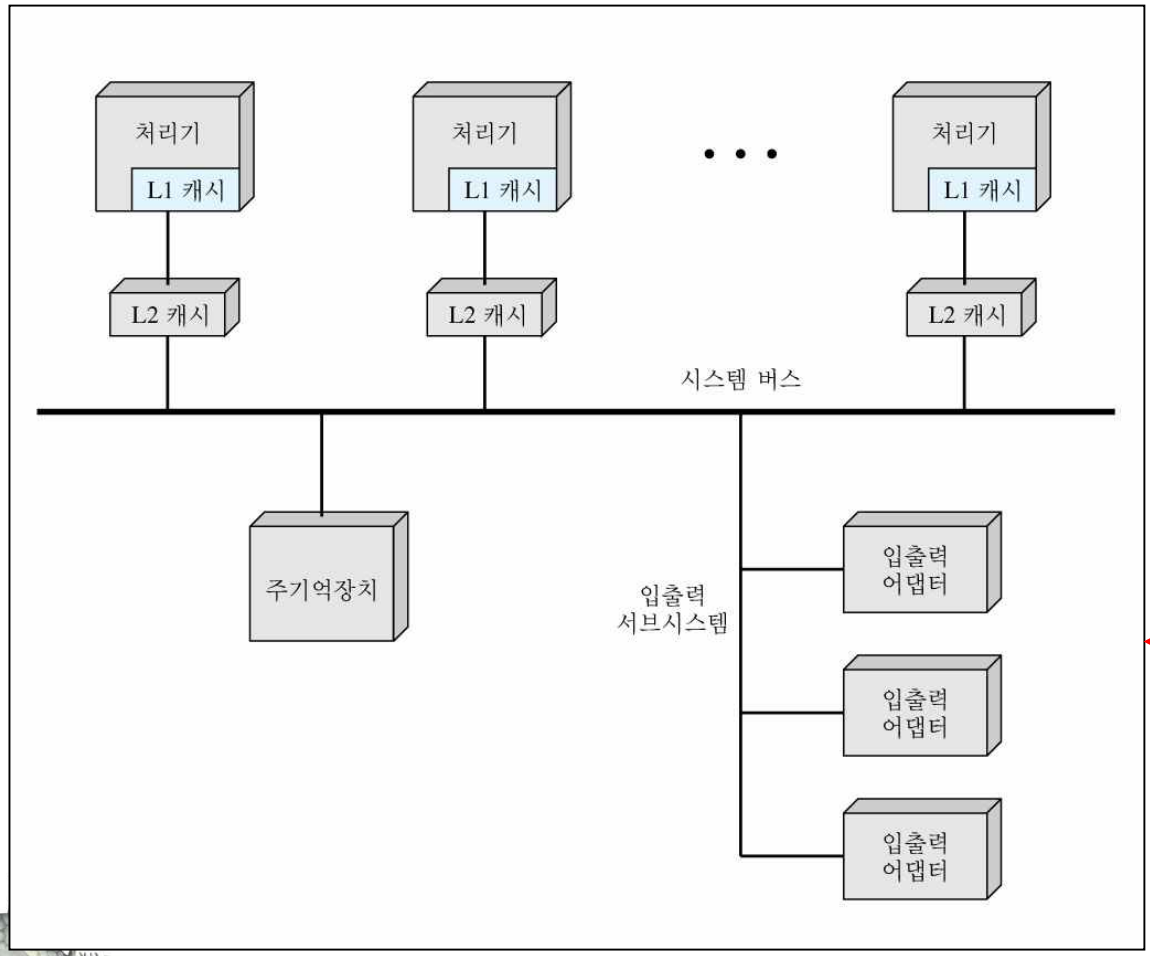
- 병렬 처리기들의 분류 (Categories of Parallel Processors)



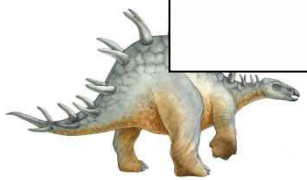


대칭적 다중처리 (계속)

- SMP 구성

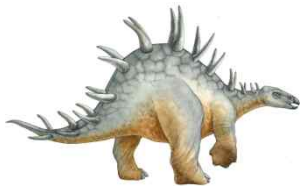


← *캐시 일관성 문제*



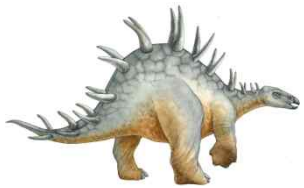
대칭적 다중처리 (계속)

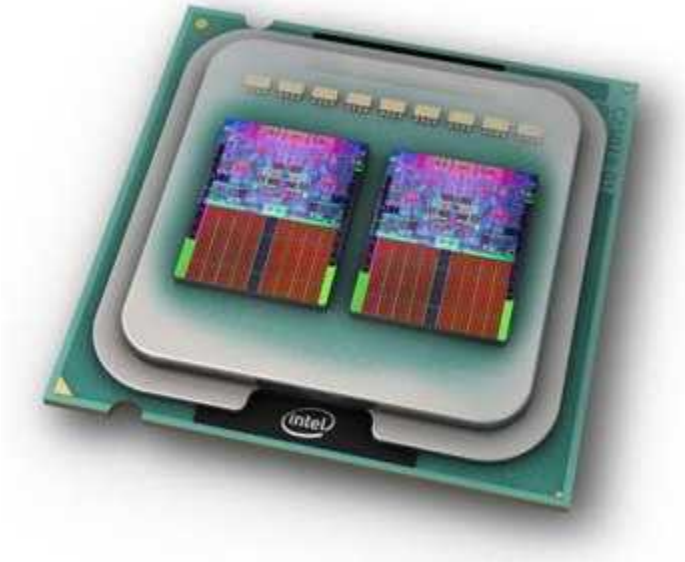
- SMP를 위한 OS 설계 시 고려 사항
  - 목적: 사용자가 다중프로그래밍 단일처리기 시스템(multiprogramming uniprocessor system)과 동일한 관점을 가질 수 있게 자원을 관리
  - 동시적 병행(simultaneous concurrent) 프로세스 또는 스레드
    - 재진입(reentrant) 커널 코드
    - 분리된(separated) 커널 자료 구조
  - SMP를 위한 프로세스(스레드) 스케줄링
    - 전역 큐 / 지역 큐
    - 집단 스케줄링(gang scheduling)
    - 캐쉬 친화성(cache affinity)



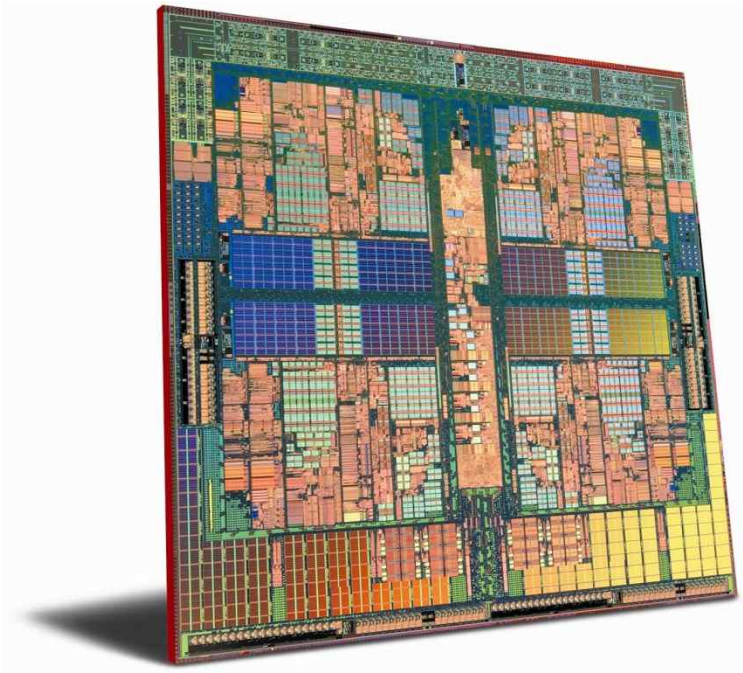
대칭적 다중처리 (계속)

- SMP를 위한 OS 설계 시 고려 사항(계속)
  - 동기화
    - 상호배제(mutual exclusion)
    - 사건 순서화(event ordering)
  - 메모리 관리
    - 다중포트 메모리(multiport memory): dualport memory
  - 신뢰성 및 결함 허용 (fault tolerance)
    - 이주 (migration)

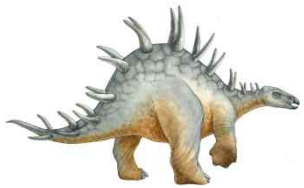




Intel Core 2 Quad(Q6600)

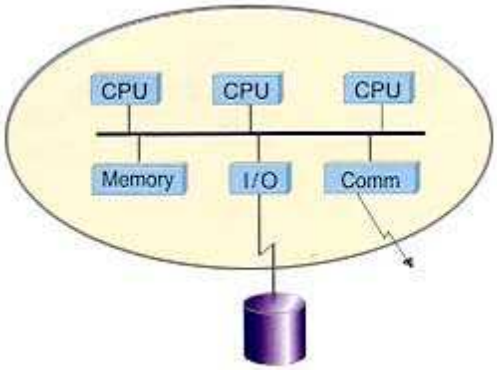


AMD Quad Core CPU(Opteron)



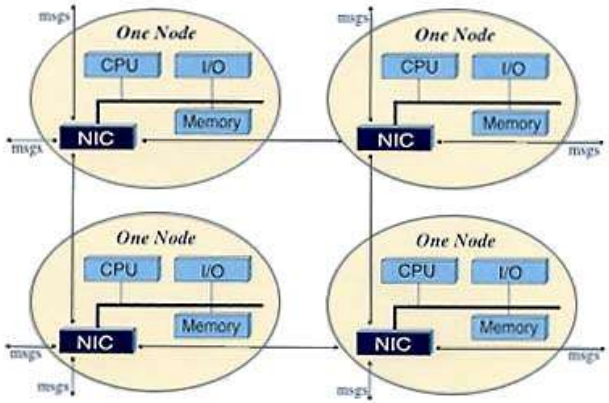
병렬 컴퓨터

- SMP



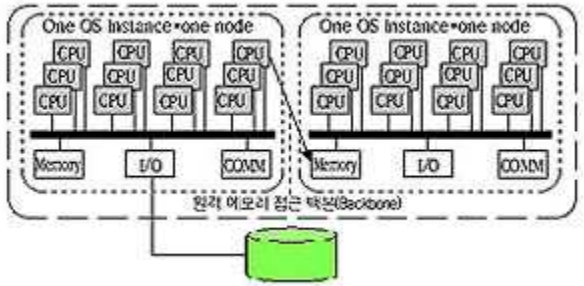
- MPP

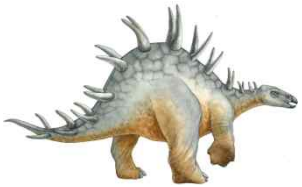
(Massive Parallel



- NUMA

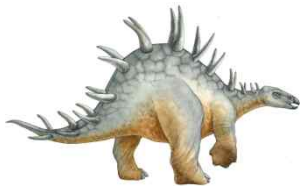
(Non-Uniform Memory Access)





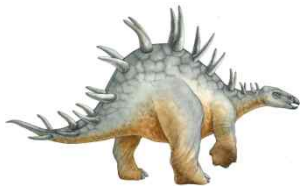
Distributed Systems

- Distribute the computation among several physical processors.
- *Loosely coupled system* – each processor has its own local memory; processors communicate with one another through various communications lines, such as high-speed buses or telephone lines.
- Advantages of distributed systems.
  - Resources Sharing
  - Computation speed up – load sharing
  - Reliability
  - Communications

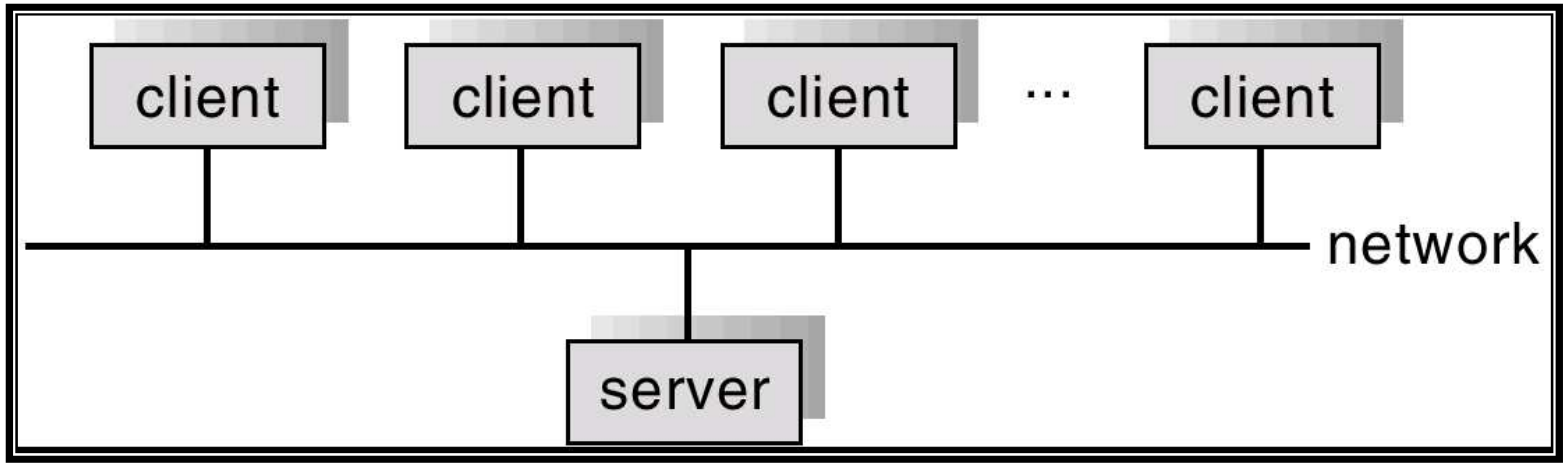


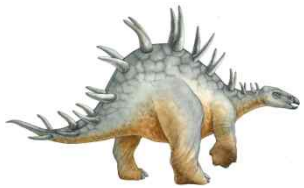
Distributed Systems (cont)

- Requires networking infrastructure.
- Local area networks (LAN) or Wide area networks (WAN)
- May be either client-server or peer-to-peer systems.



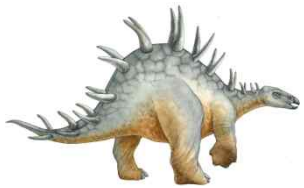
General Structure of Client-Server





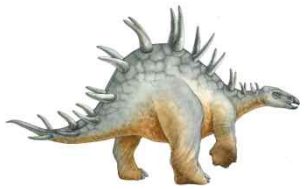
Real-Time Systems

- Often used as a control device in a dedicated application such as controlling scientific experiments, medical imaging systems, industrial control systems, and some display systems.
- Well-defined fixed-time constraints.
- Real-Time systems may be either *hard* or *soft* real-time.



Real-Time Systems (Cont.)

- Hard real-time:
  - Secondary storage limited or absent, data stored in short term memory, or read-only memory (ROM)
  - Conflicts with time-sharing systems, not supported by general-purpose operating systems.
- Soft real-time
  - Limited utility in industrial control of robotics
  - Useful in applications (multimedia, virtual reality) requiring advanced operating-system features.

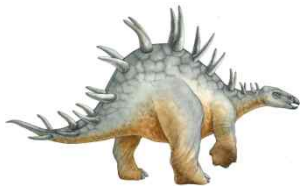


Handheld Systems

- Personal Digital Assistants (PDAs)
- Cellular telephones
- Issues:
  - Limited memory
  - Slow processors
  - Small display screens.





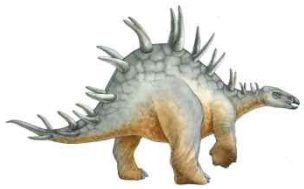



Clustered Systems

- Clustering allows two or more systems to share storage.
- Provides high reliability.
- *Asymmetric clustering*: one server runs the application while other servers standby.
- *Symmetric clustering*: all N hosts are running the application.

http://www.top500.org/

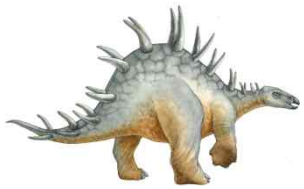
Desing of Cluster Computer : http://www.scl.ameslab.gov/Projects/parallel_computing/cluster_design.html
Examples of Cluster Computer : http://www.scl.ameslab.gov/Projects/parallel_computing/cluster_examples.html

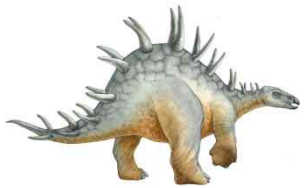


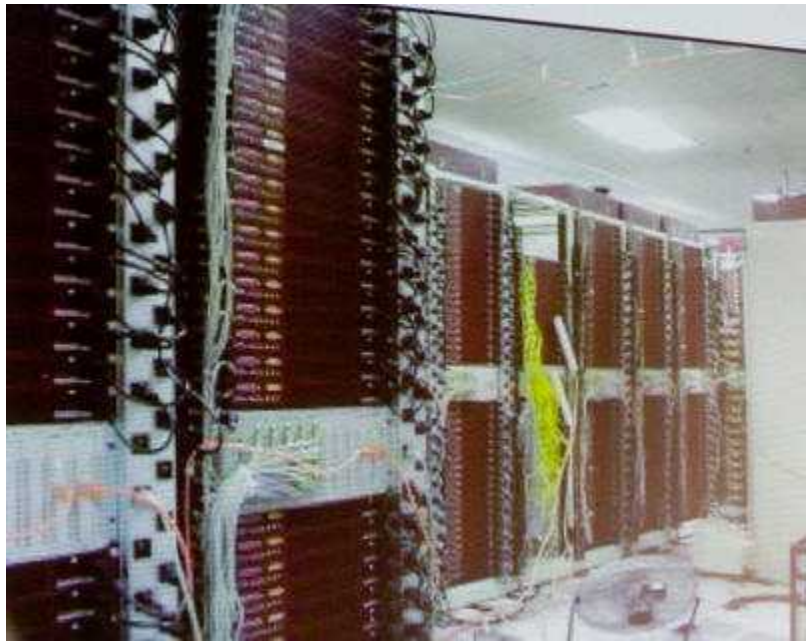
TOP 500

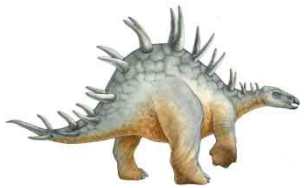
- Top 500
  - www.top500.org

Rank	Site	Computer/Year Vendor	Cores	R_{max}	R_{peak}	Power
1	Oak Ridge National Laboratory United States	Jaguar - Cray XT5-HE Opteron Six Core 2.6 GHz / 2009 Cray Inc.	224162	1759.00	2331.00	6950.60
2	National Supercomputing Centre in Shenzhen (NSCS) China	Nebulae - Dawning TC3600 Blade, Intel X5650, NVidia Tesla C2050 GPU / 2010 Dawning	120640	1271.00	2984.30	
3	DOE/NNSA/LANL United States	Roadrunner - BladeCenter QS22/LS21 Cluster, PowerXCell 8i 3.2 Ghz / Opteron DC 1.8 GHz, Voltaire Infiniband / 2009 IBM	122400	1042.00	1375.78	2345.50
4	National Institute for Computational Sciences/University of Tennessee United States	Kraken XT5 - Cray XT5-HE Opteron Six Core 2.6 GHz / 2009 Cray Inc.	98928	831.70	1028.85	
5	Forschungszentrum Juelich (FZJ) Germany	JUGENE - Blue Gene/P Solution / 2009 IBM	294912	825.50	1002.70	2268.00
6	NASA/Ames Research Center/NAS United States	Pleiades - SGI Altix ICE 8200EX/8400EX, Xeon HT QC 3.0/Xeon Westmere 2.93 Ghz, Infiniband / 2010 SGI	81920	772.70	973.29	3096.00
7	National SuperComputer Center in Tianjin/NUDT China	Tianhe-1 - NUDT TH-1 Cluster, Xeon E5540/E5450, ATI Radeon HD 4870 2, Infiniband / 2009 NUDT	71680	563.10	1206.19	
8	DOE/NNSA/LLNL United States	BlueGene/L - eServer Blue Gene Solution / 2007 IBM	212992	478.20	596.38	2329.60
9	Argonne National Laboratory United States	Intrepid - Blue Gene/P Solution / 2007 IBM	163840	458.61	557.06	1260.00
10	Sandia National Laboratories / National Renewable Energy Laboratory United States	Red Sky - Sun Blade x6275, Xeon X55xx 2.93 Ghz, Infiniband / 2010 Sun Microsystems	42440	433.50	497.40	
11	Texas Advanced Computing Center/Univ. of Texas United States	Ranger - SunBlade x6420, Opteron QC 2.3 Ghz, Infiniband / 2008 Sun Microsystems	62976	433.20	579.38	2000.00
12	DOE/NNSA/LLNL United States	Dawn - Blue Gene/P Solution / 2009 IBM	147456	415.70	501.35	1134.00
13	Moscow State University - Research Computing Center Russia	Lomonosov - T-Platforms T-Blade2, Xeon 5570 2.93 GHz, Infiniband QDR / 2009 T-Platforms	35360	350.10	414.42	

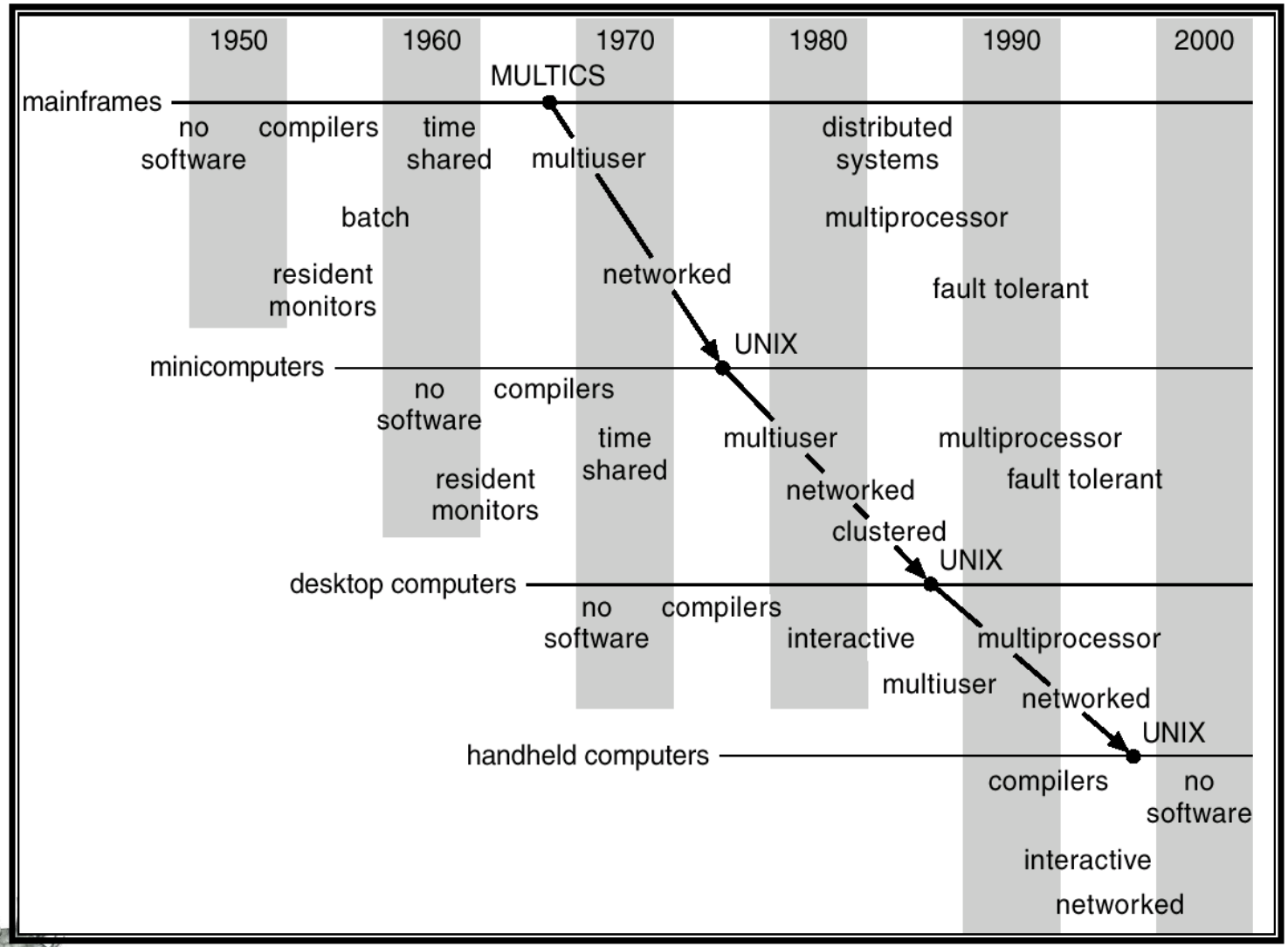


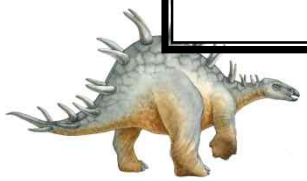






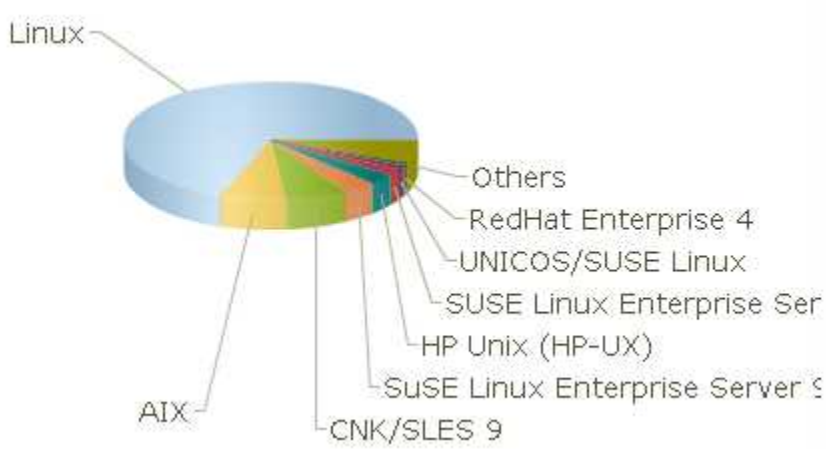
Migration of Operating-System Concepts and Features



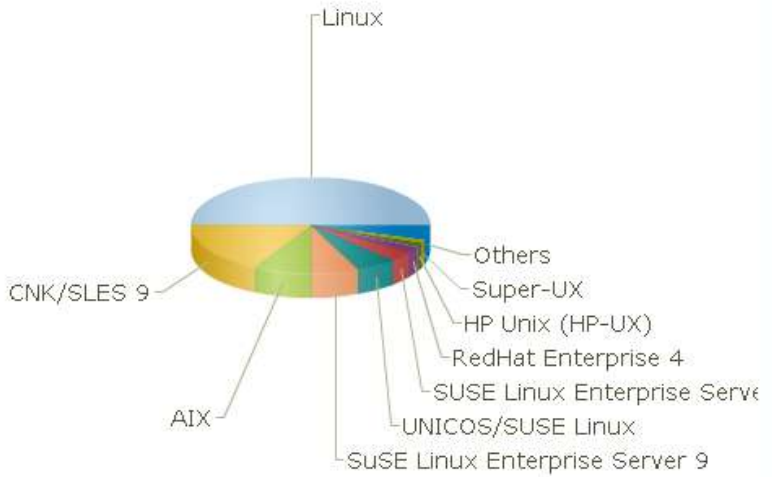


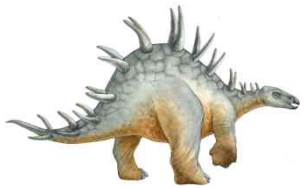
Current OS in TOP 500

- Systems 기준



- Performance 기준





Computing Environments

- Traditional computing
- Web-Based Computing
- Embedded Computing