

# OPERATING SYSTEMS

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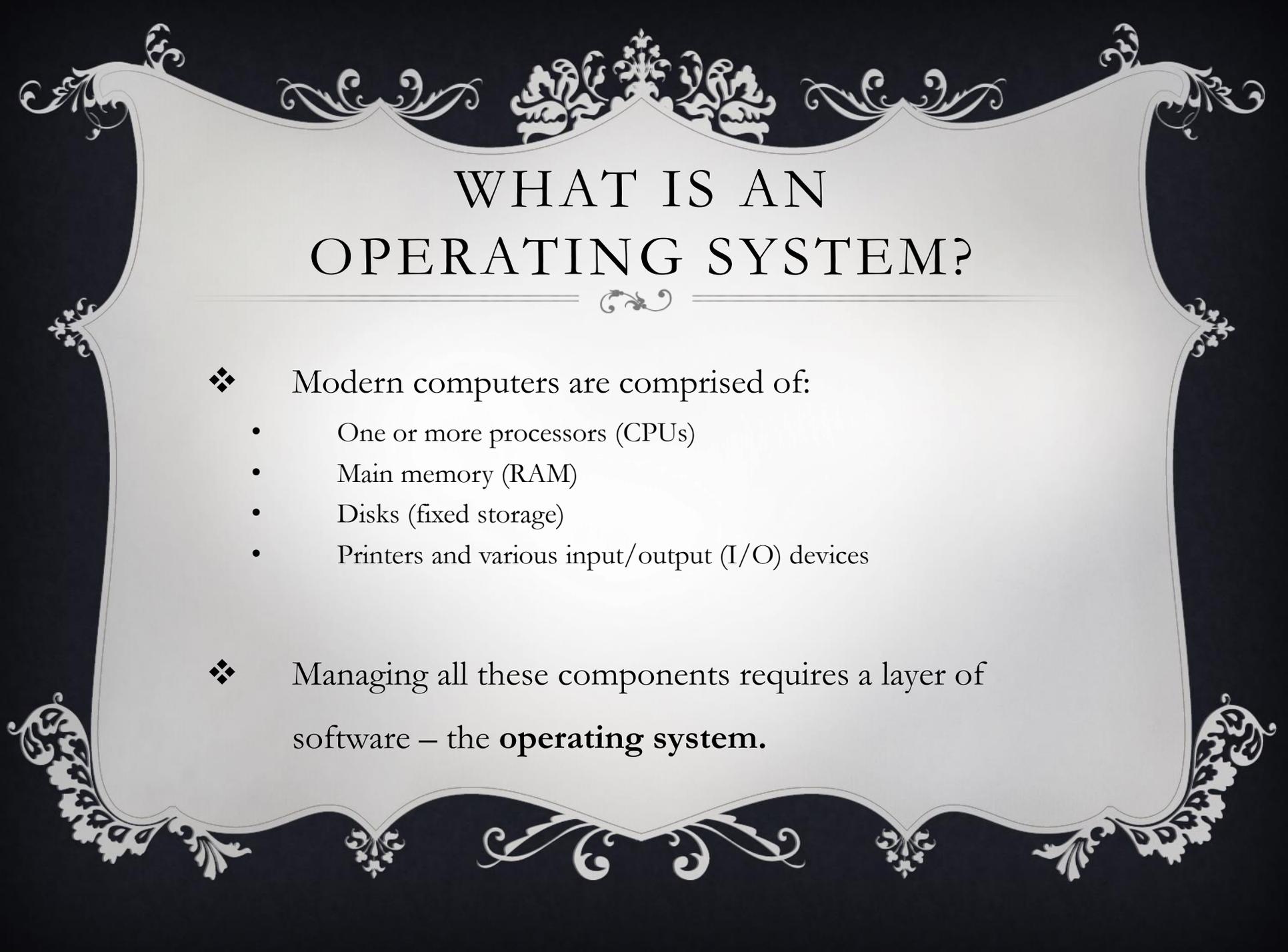


*What is an Operating System... ?*

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INTRODUCTION

*after A.S.Tanenbaum,  
Modern Operating Systems, 3rd edition*



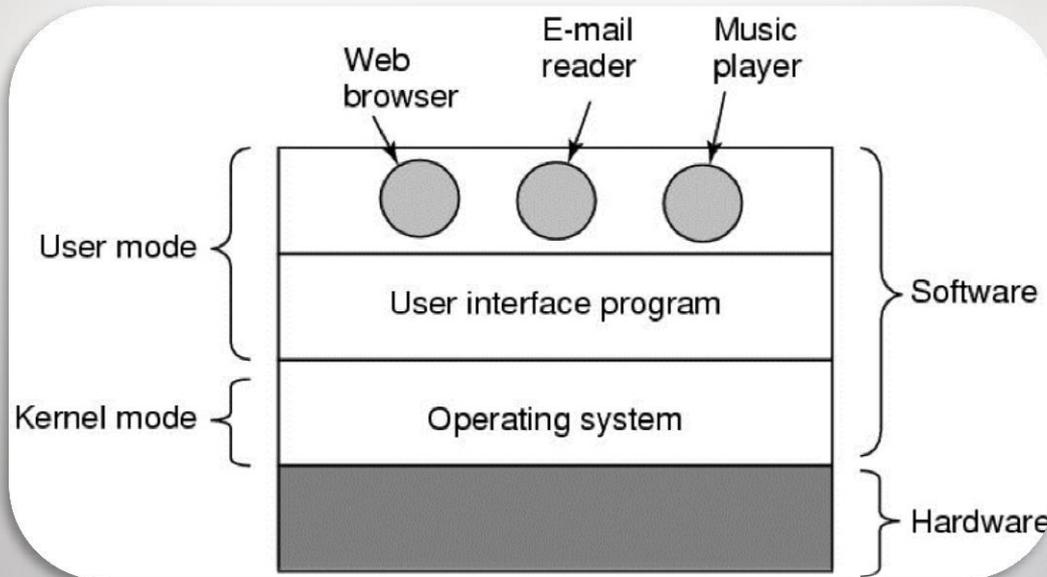
# WHAT IS AN OPERATING SYSTEM?

- ❖ Modern computers are comprised of:
  - One or more processors (CPUs)
  - Main memory (RAM)
  - Disks (fixed storage)
  - Printers and various input/output (I/O) devices
  
- ❖ Managing all these components requires a layer of software – the **operating system**.

# WHAT IS AN OPERATING SYSTEM?

- ❖ Every computing system has four basic components:
  - The hardware
  - Application programs
  - The operating system
  - The users
- ❖ The **operating system** can be considered as a bond between the other three components.

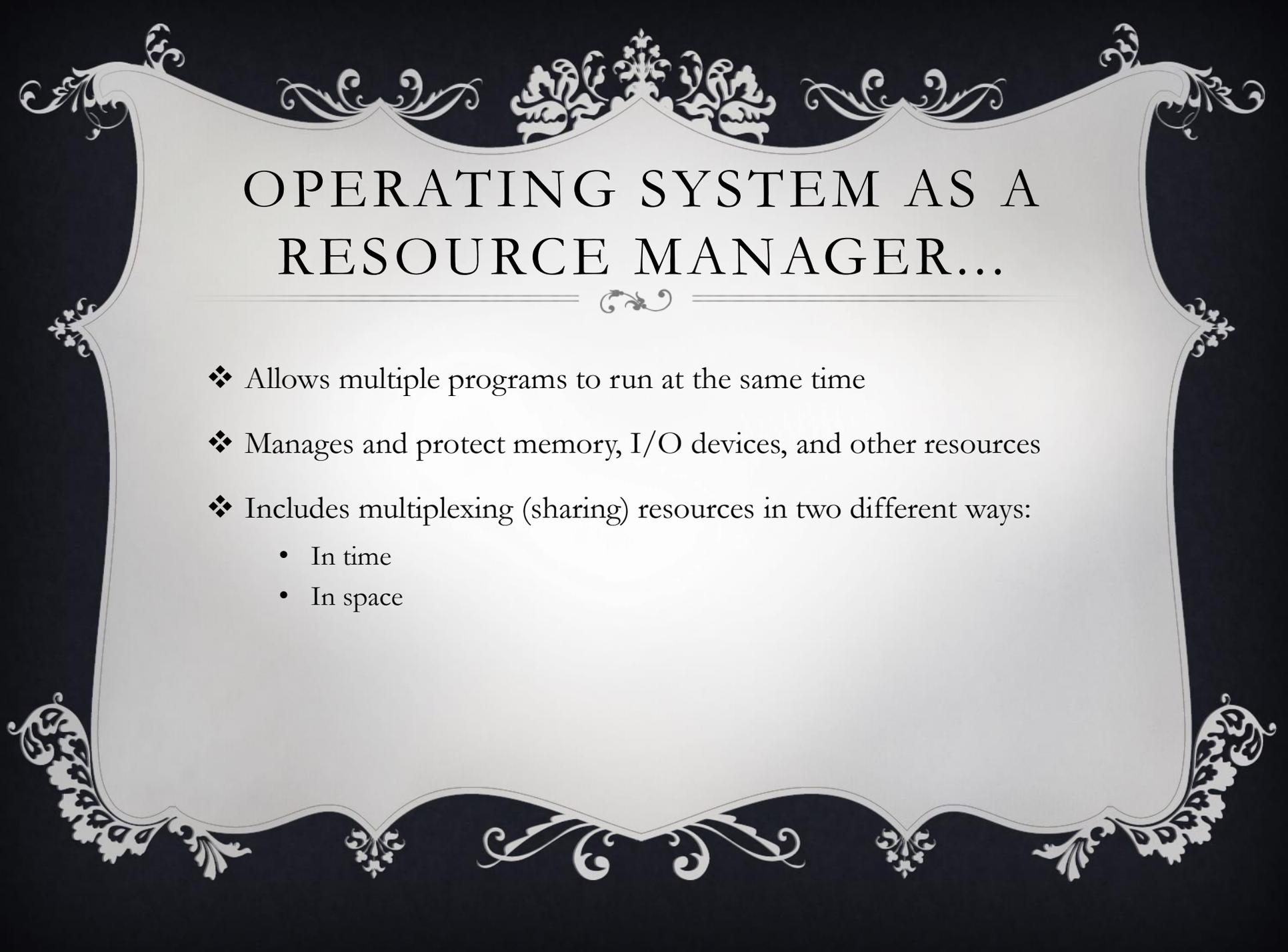
# THE OPERATING SYSTEM AS A BOND...



The operating system layout in a computational machine.

# OPERATING SYSTEM AS AN EXTENDED MACHINE...

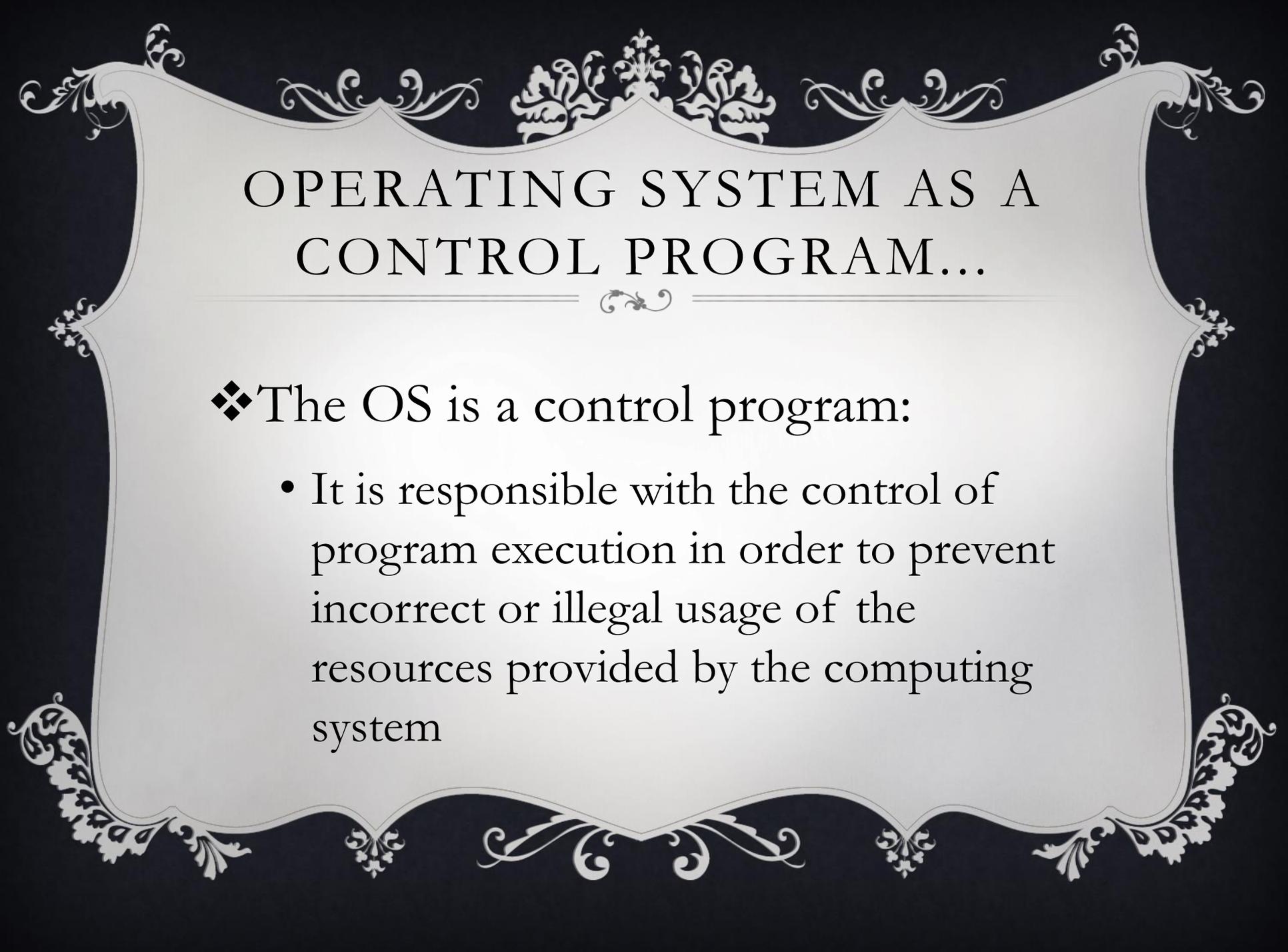
- ❖ The operating system as an extended machine:
  - Offers an environment where the three basic components (hardware, software and system data) can be used properly;
  - Hides all the underlying functioning details of the hardware devices, by offering an uniform interface for their usage (the interface of system calls).



# OPERATING SYSTEM AS A RESOURCE MANAGER...

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- ❖ Allows multiple programs to run at the same time
- ❖ Manages and protect memory, I/O devices, and other resources
- ❖ Includes multiplexing (sharing) resources in two different ways:
  - In time
  - In space



# OPERATING SYSTEM AS A CONTROL PROGRAM...

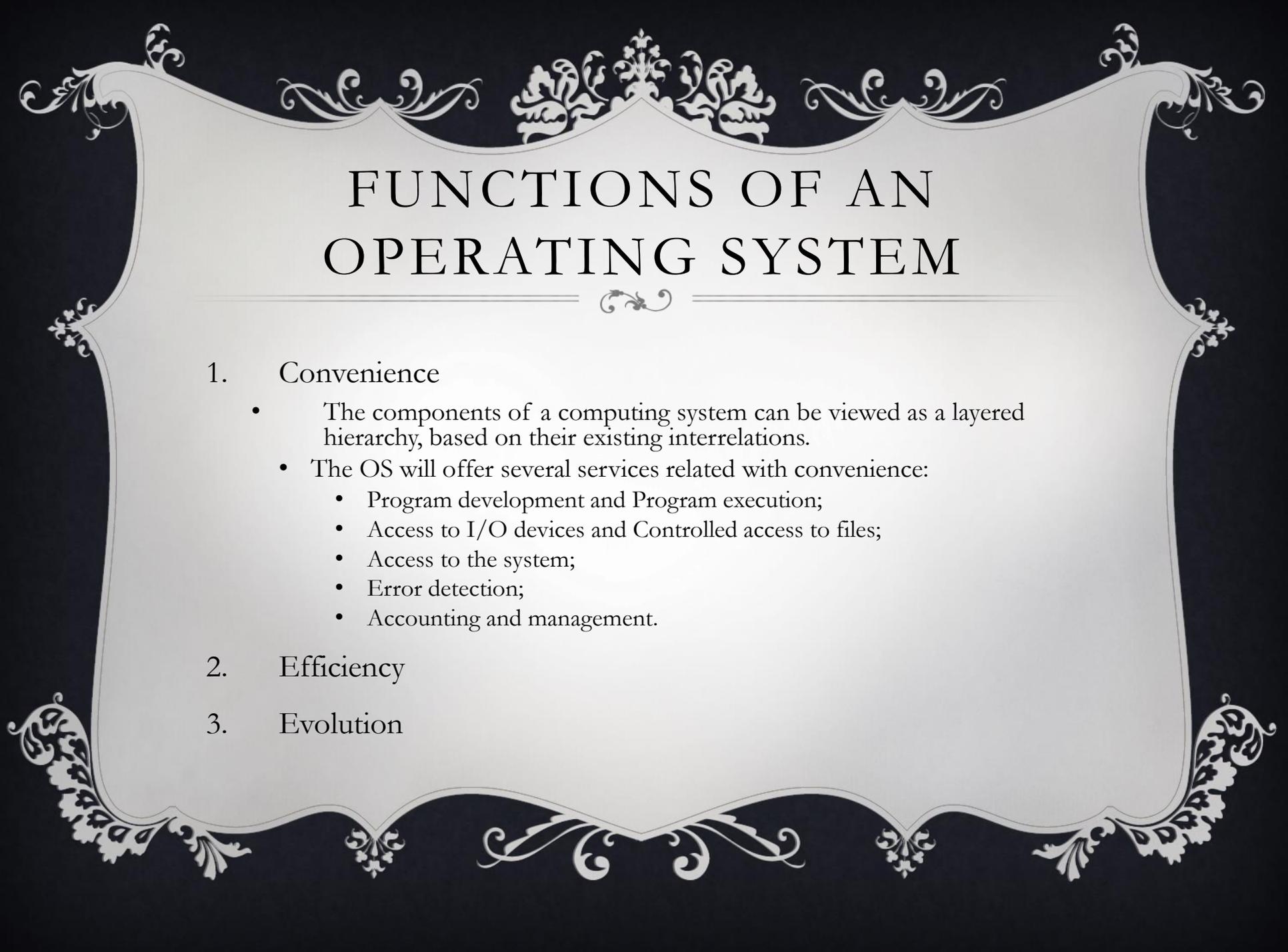
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❖ The OS is a control program:

- It is responsible with the control of program execution in order to prevent incorrect or illegal usage of the resources provided by the computing system

# THE OPERATING SYSTEM...

- ❖ ...As an extension of the machine
  - Is able to offer a virtual machine, hiding all the details of the underlying physical machine;
  - The virtual machine is easier to be used or programmed than the physical machine.
- ❖ ...As a resource manager
  - Assures a controlled and ordered resource allocation.
- ❖ ...As a control program
  - Offers an outstanding treatment for input/output devices.



# FUNCTIONS OF AN OPERATING SYSTEM

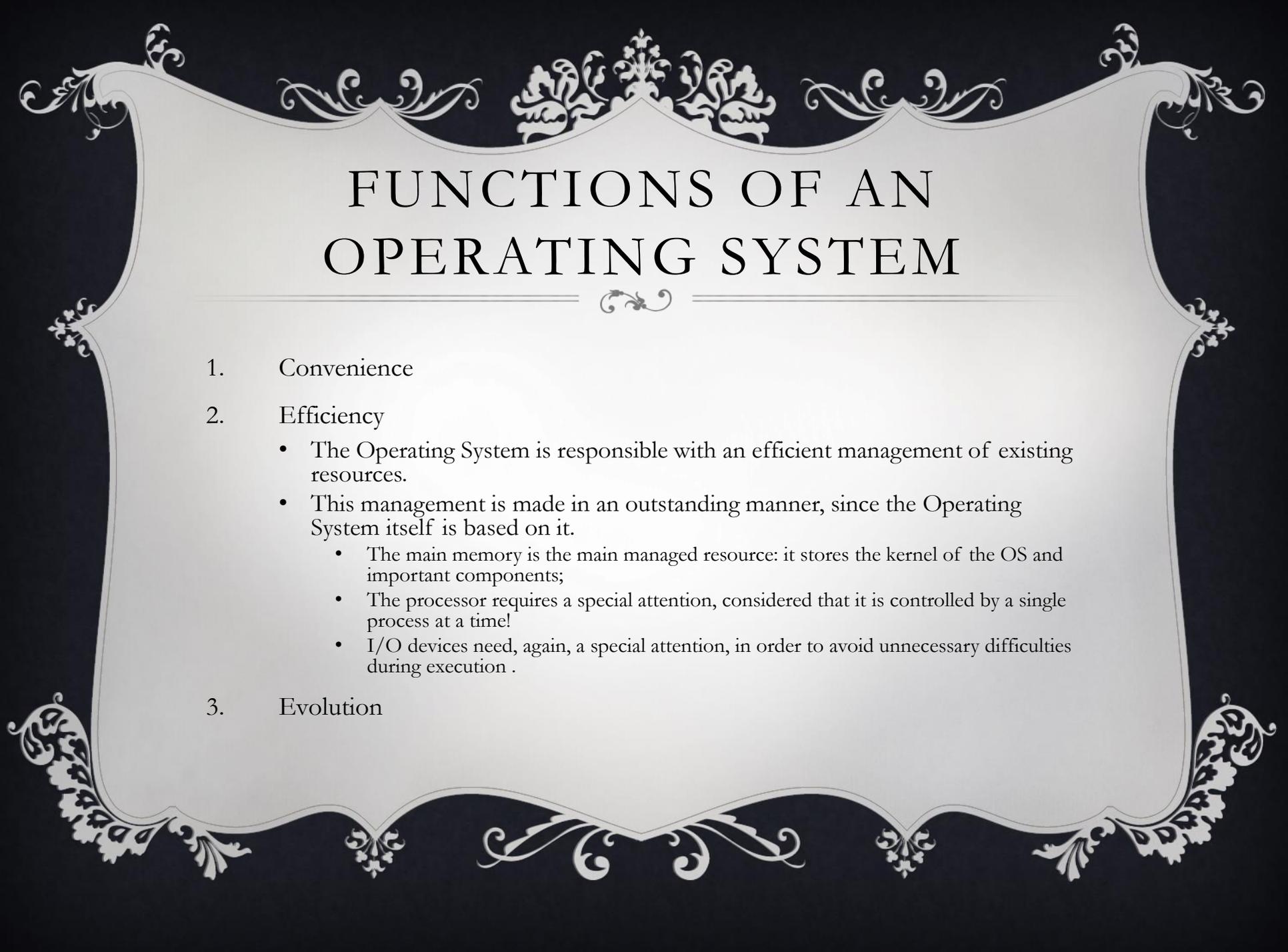
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## 1. Convenience

- The components of a computing system can be viewed as a layered hierarchy, based on their existing interrelations.
- The OS will offer several services related with convenience:
  - Program development and Program execution;
  - Access to I/O devices and Controlled access to files;
  - Access to the system;
  - Error detection;
  - Accounting and management.

## 2. Efficiency

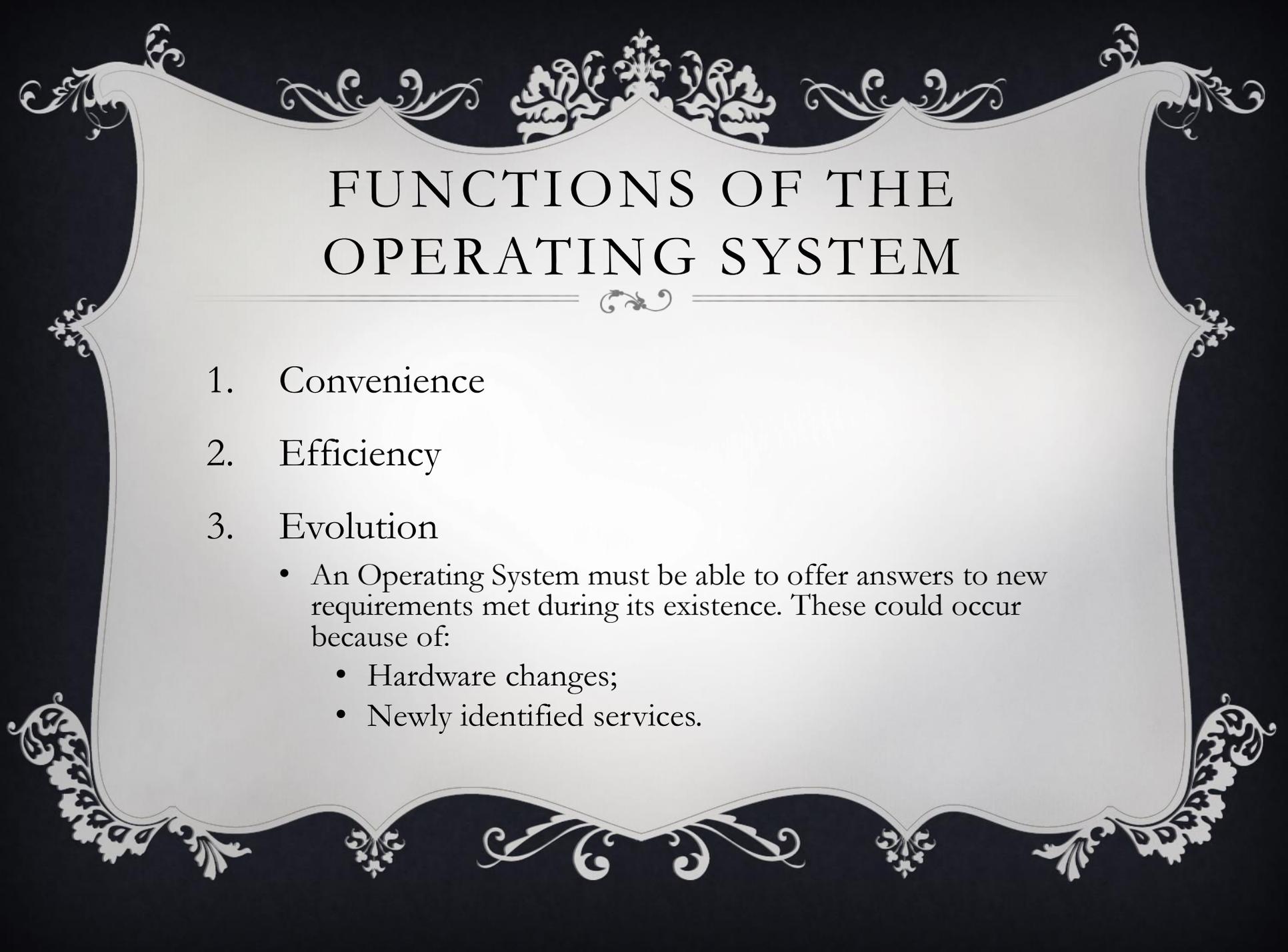
## 3. Evolution



# FUNCTIONS OF AN OPERATING SYSTEM

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1. Convenience
2. Efficiency
  - The Operating System is responsible with an efficient management of existing resources.
  - This management is made in an outstanding manner, since the Operating System itself is based on it.
    - The main memory is the main managed resource: it stores the kernel of the OS and important components;
    - The processor requires a special attention, considered that it is controlled by a single process at a time!
    - I/O devices need, again, a special attention, in order to avoid unnecessary difficulties during execution .
3. Evolution



# FUNCTIONS OF THE OPERATING SYSTEM

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1. Convenience
2. Efficiency
3. Evolution
  - An Operating System must be able to offer answers to new requirements met during its existence. These could occur because of:
    - Hardware changes;
    - Newly identified services.

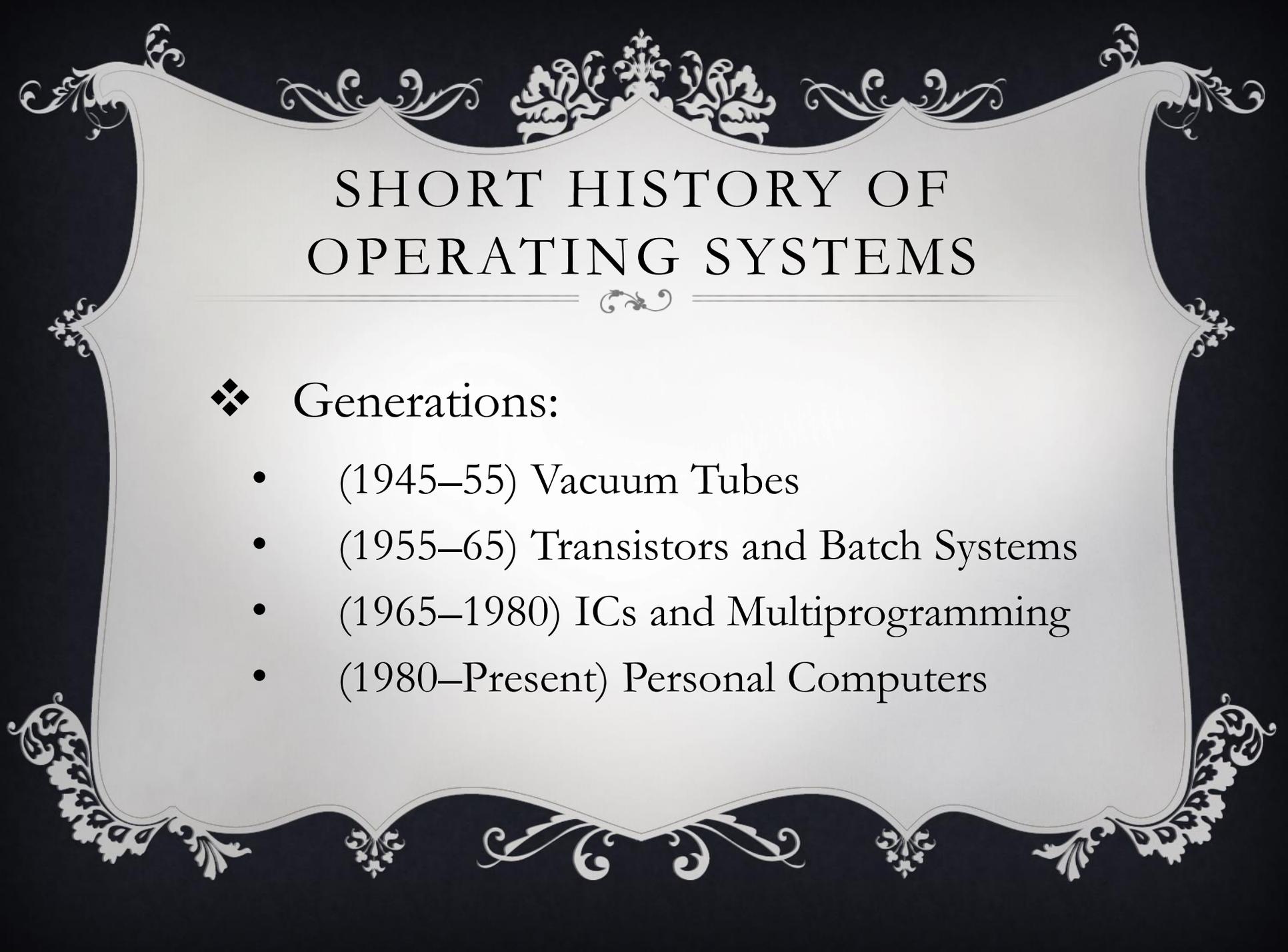


*Short History of Operating Systems*



# INTRODUCTION

*after A.S.Tanenbaum,  
Modern Operating Systems, 3rd edition*



# SHORT HISTORY OF OPERATING SYSTEMS

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## ❖ Generations:

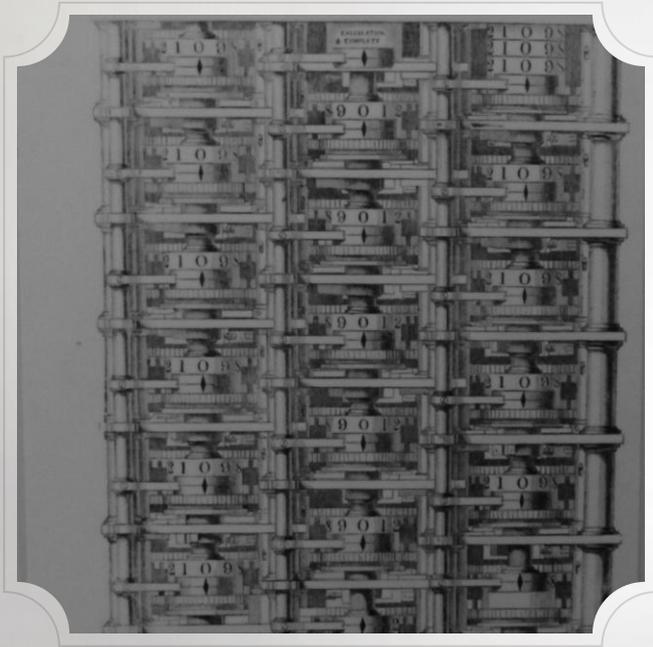
- (1945–55) Vacuum Tubes
- (1955–65) Transistors and Batch Systems
- (1965–1980) ICs and Multiprogramming
- (1980–Present) Personal Computers



## CHARLES BABBAGE AND ADA OF LOVELACE

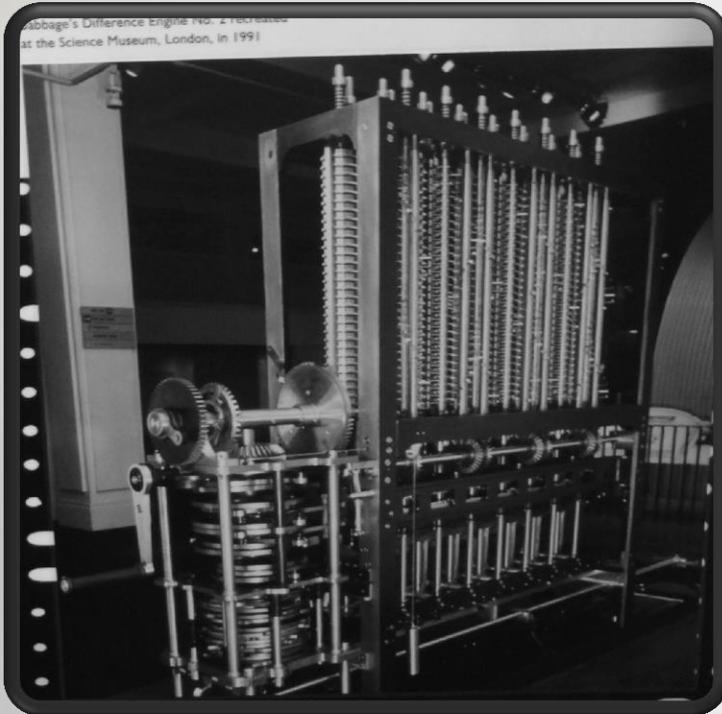
The creator of first “computer”  
and its first programmer...

You can find a copy of this  
difference machine, developed by  
Ch.Babbage, at the Science  
Museum in London



## **DIFFERENCE MACHINE**

Parts of the differential machine  
(1853), developed by Ch. Babbage



## **THE DIFFERENTIAL (DIFFERENCE) ENGINE**

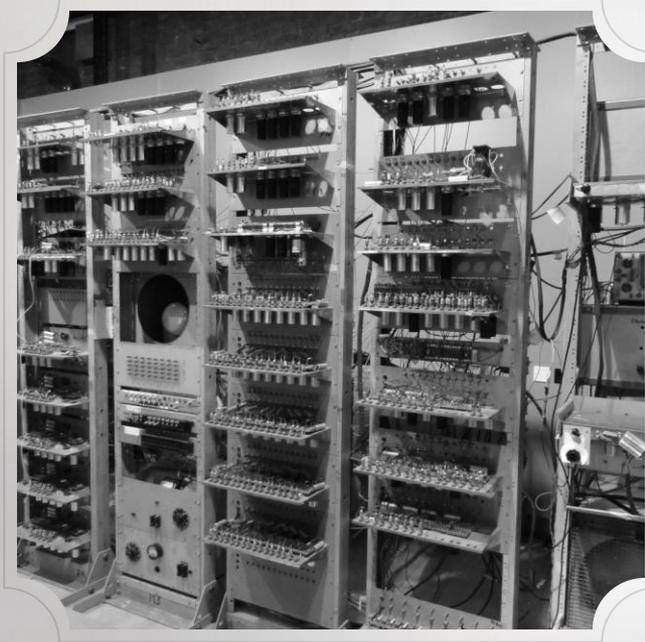
Babbage's difference machine, at the  
Science Museum, London (1991)

## (1945-55) VACUUM TUBES

❖ Low computing power, high costs, difficult to operate, very high dimensions.

- Job scheduling was by... operator scheduling.
- No real specialization of humans.
- Punched cards were developed and used as the main mean for program input.

❖ The basis of the very first programming languages.



## **BABY – MANCHESTER UNIV**

An experimental machine, developed in late '40, for checking if it was possible to execute some stored programs.

The system offered over 500 thermionic valves and wiring, for easier access to different components.

BABY executed first program in 1948



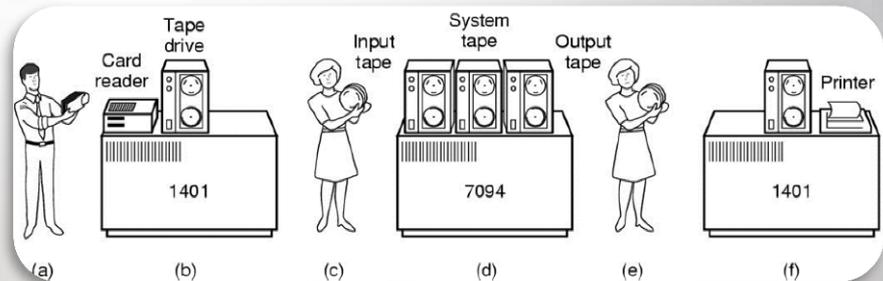
# (1945-55) TRANSISTORS AND BATCH SYSTEMS

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- ❖ Transistors era begin. Smaller systems.
- ❖ A need for controlled working environment.
- ❖ Very first high level programming languages are highly used.
- ❖ Usage of punched cards offer the means of operating improvement.
- ❖ Development of *batch processing systems*: Magnetic tapes are developed in order to offer the support for higher capacity storage.

# (1955-65) TRANSISTORS AND BATCH SYSTEMS

- ❖ An early batch processing system:
  - a) Programmers bring cards to 1401.
  - b) 1401 reads batch of jobs onto tape.
  - c) Operator carries input tape to 7094.
  - d) 7094 does computing.
  - e) Operator carries output tape to 1401.
  - f) 1401 prints output.





**OPERATION OF A  
SECOND  
GENERATION  
COMPUTER**

# (1955-65) TRANSISTORS AND BATCH SYSTEMS

- ❖ *Off-line processing* is developed: data and programs are prepared on simpler, specialized machines; data processing is also moved on these machines.
- ❖ *Control cards* are developed. This is the first step to operation automation.
- ❖ The development of the *resident monitor*.



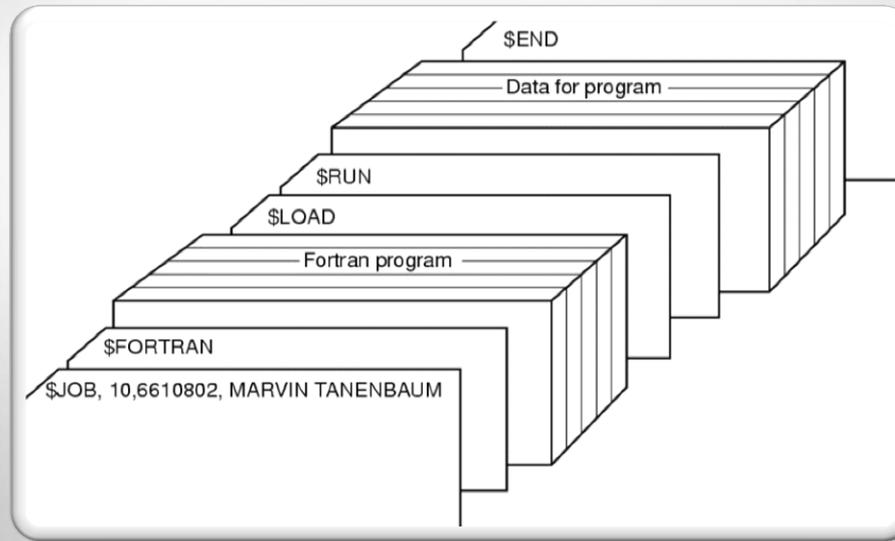
## **PUNCHED CARDS**

Punched cards were used in different domains.

Textile industry was, again, the source of this outstanding invention.

Notice that IBM started its existence by developing some (tabulating) machines that were able to use... punched cards

# (1955-65) TRANSISTORS AND BATCH SYSTEMS



❖ Structure of a typical FMS job.

# (1955-65) TRANSISTORS AND BATCH SYSTEMS

## ❖ The resident monitor

- A new component to use the control cards and to offer automated job succession;
- The first “real” operating system;
- The monitor is small computer program, permanently kept in memory;
- Its main purpose is to transfer the control to (computer) programs and to take the control from the programs, once their job is done.

## ❖ The resident monitor has three basic components:

- the loader, the (control) card interpreter, and the device drivers.

## PERIPHERICS

One can identify different types of peripherals, including

- card writer (puncher)
- card reader
- line printer
- teletype

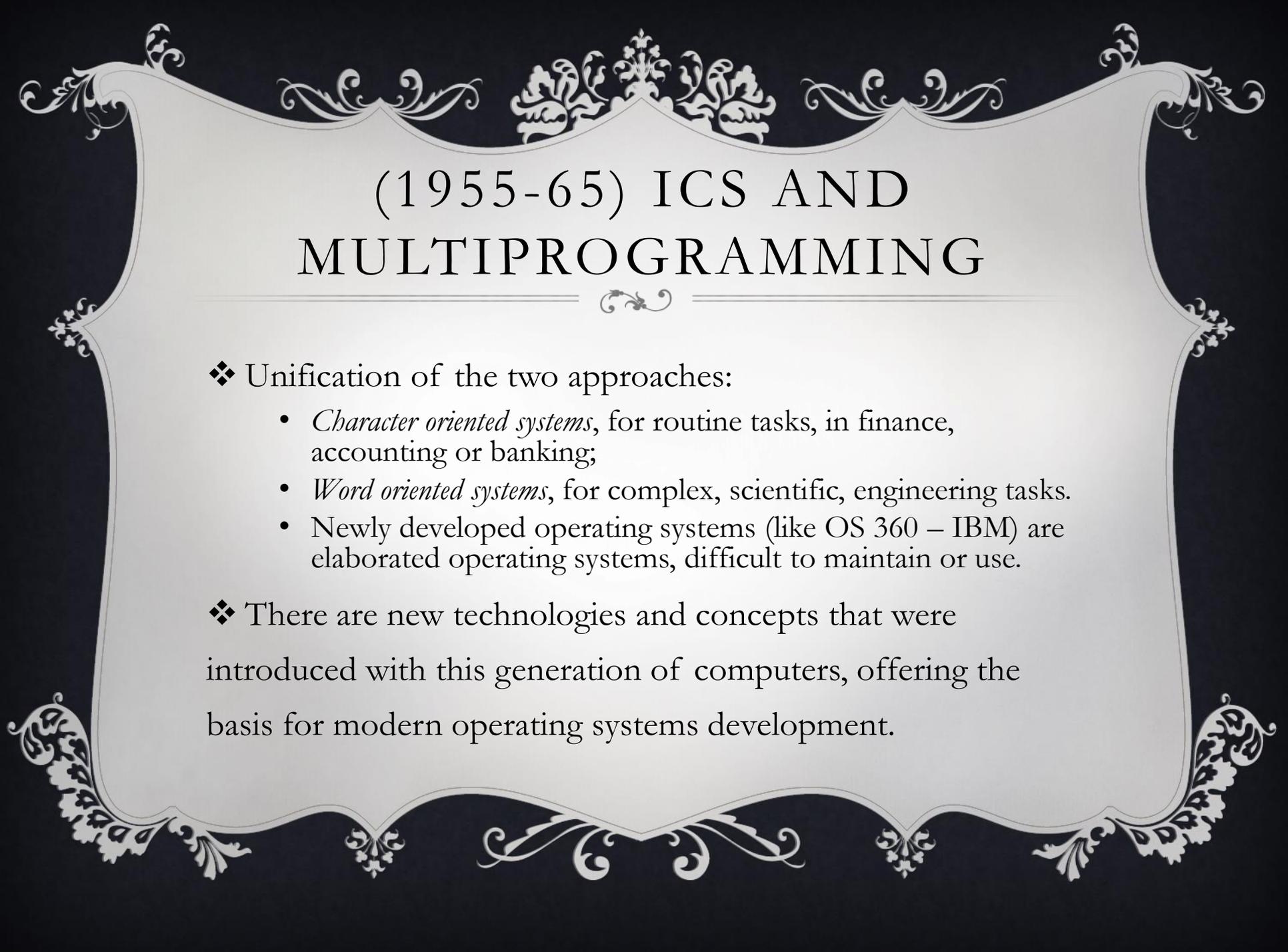
And, of course, parts of the computer ...



# (1955-65) TRANSISTORS AND BATCH SYSTEMS

## ❖ Operation overlapping

- *Off-line processing* is based on the development of magnetic tapes.
- The (computer) programs are read from a tape unit, and their results are stored on separate tape units. Later operation of magnetic tapes was made remotely on dedicated machines for these simple operations.
- Operating times are improved, but the direct access to the magnetic tape does not offer very great improvements.



## (1955-65) ICS AND MULTIPROGRAMMING

❖ Unification of the two approaches:

- *Character oriented systems*, for routine tasks, in finance, accounting or banking;
- *Word oriented systems*, for complex, scientific, engineering tasks.
- Newly developed operating systems (like OS 360 – IBM) are elaborated operating systems, difficult to maintain or use.

❖ There are new technologies and concepts that were introduced with this generation of computers, offering the basis for modern operating systems development.

# (1955-65) ICS AND MULTIPROGRAMMING

## ❖ *Spooling*

- Going back to on-line operation;
- Simultaneous Peripheral Operation On-Line based on disk-units, used for “permanent” storage;
- Spooling is possible due to the development of random access storage devices.

## ❖ *Multiprogramming*

- Based on the idea of partitioning the main memory: it is able to hold several jobs simultaneously;
- Multiprogramming improves the spooling technique;
- Requires new technologies for hardware and software protection of processes against the others;
- With multiprogramming, the processor has the possibility to choose the next process to be run. **Real process scheduling** is possible.

# (1955-65) ICS AND MULTIPROGRAMMING

## ❖ *Timesharing*

- Timesharing is a variant of multiprocessing where the processor time is split between the processes stored in the main memory. For execution, the processor will permanently switch between these processes;
- Timesharing involves new, advanced, protection mechanisms and devices.
- With timesharing now it is possible to provide user's interaction with the system. Several innovations can be introduced now:
  - File systems;
  - Interactive tools (such as editors, compilers, etc.)
  - Keyboards and monitors;
  - Virtual memory;

