

History of Operating Systems

Operating Systems

## G530PS: Operating Systems

Graham Kendall

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## Levy, S. 1984. Hackers: Heroes of the Computer Revolution

*"A hack: a neat or smart way of fixing or implementing something."*

*"The first section of the book describes the rise of the original computer hacker, and the Hacker Ethos that came with it."*



*"This is a great book covering three influential sections of computing history."*

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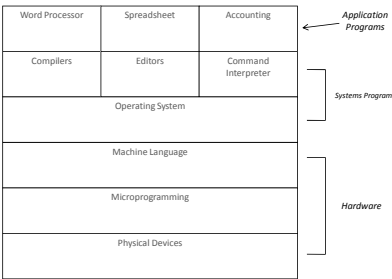
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## Give three functions of an operating system?

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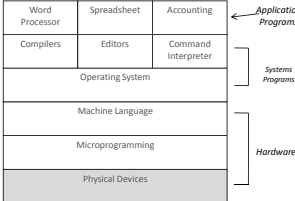
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## Physical Devices

Integrated circuits, cathode ray tubes, wire etc.



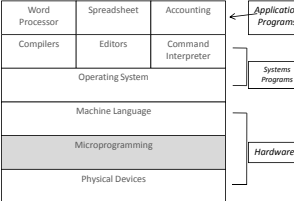
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## Microprogramming

Firmware, Provides basic operations that allow communication with physical devices, Normally read only (this firmware)



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### Machine Language

Defines the instruction set of the computer, Software – but can be considered as hardware

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### Operating System

Layer between hardware and software, allows use of hardware in a “user friendly” way. Provides a layer of abstraction

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### System Programs

Useful to “System Programmers”, Used (and written) by expert users

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### Application Programs

Probably the things we are most familiar with

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### Another view of an operating system

**A Resource Manager**

- Operating System is seen as a way of providing the users of the computer with the resources they need at any given time.
- Some resource requests may not be able to be met (memory, CPU usage etc.) but the operating system is able to deal with scheduling problems such as these.
- Other resources have a layer of abstraction placed between them and the physical resource (e.g. a printer).

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### Another view of an operating system

**Extended or Virtual Machine**

- The operating system is seen as a way of not having to deal with the complexity of the hardware (e.g. floppy disc controller).

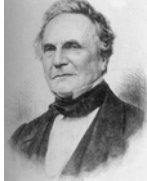
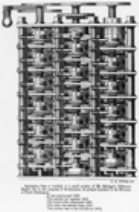
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### Charles Babbage: Analytical Engine

- Attributed with designing the first digital computer
- Was never actually built
- No operating system

26<sup>th</sup> Dec 1791 – 18<sup>th</sup> Oct 1871

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### First Generation (1945-1955)



- Developed during the war
- Vacuum Tubes
- Many people were developing automatic calculating machines
- Filled entire rooms
- No operating system
- No programming languages
- Had to physically wire the computer to carry out the intended instructions

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### ENIAC

McCartney S. (2001) *Eniac: The Triumphs and Tragedies of the World's First Computer*, Berkeley Publishing Group

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### Second Generation (1955-1965)

- Transistors
- More reliable
- Became feasible to manufacture computers that could be sold to customers
- Job of computer operator invented
- Batch jobs introduced in order to improve throughput (via tapes)
- Can be seen as the first operating system

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### Third Generation (1965-1980)

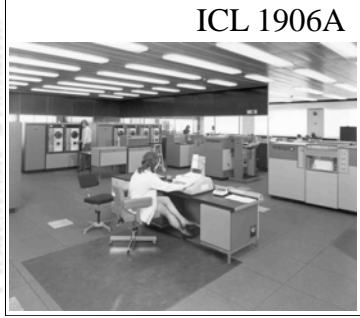
- Integrated Circuits as a replacement for transistors
- IBM introduced its System/360 range and ICL introduced its 1900 range
- The start of multiprogramming which led to a need for a more complex operating system – but no virtual memory
- Spooling – both input and output
- Concept of time sharing introduced which allows interactive working
- Operating systems had to become a lot more complex in order to deal with all these issues

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### ICL 1906A



The Chilton ICL 1906A in 1971, photograph courtesy Atlas Computer Laboratory, Chilton

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### Fourth Generation (1980-present)

- Large Scale Integration (LSI)
- Led directly to the development of the personal computer (PC)
- One of the requirements for the original IBM PC was an operating system - Bill Gates supplied MS-DOS
- On non-Intel processors, the UNIX operating system was also being used.

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### Another View

- First, Second and Third generation as before and for same reasons
- Fourth generation started in 1971 with the introduction of LSI, then VLSI (Very Large Scale Integration) and then ULSI (Ultra Large Scale Integration)
- Really, just arguing about when the PC revolution started. Was it in the early 70's when LSI first became available? Or was it in 1980, when the IBM PC was launched?

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### Fifth Generation

- What will constitute a fifth generation computer?

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### Fifth Generation

- Computer generations were influenced by new hardware (vacuum tubes, transistors, integrated circuits and LSI).
- Fifth generation may break with that tradition
- One view is that a fifth generation computer will interact with humans in a way that is natural to us. Computers will be able to reason in a way that imitates humans
- Being able to accept (and understand!) the spoken word and carry out reasoning is complex, requiring advances in software and maybe hardware

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### Fifth Generation

- What advances do we need to make to realise a fifth generation computer?

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### Fifth Generation

- Advances will be needed in AI including NLP?
- Maybe need parallel processing?
- Maybe a non-silicon computer?
- The first time a generation has not been motivated by advances in hardware?

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**ICL Operating Systems**  
**Manual Executive**

- Introduced with its 1900 range
- Manual operating system
- Operators had to load and run each program

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Operating Systems

**ICL Operating Systems**  
**George 1/2/2+**

- GGeneral ORGanisation Environment
- Ran "on top" of manual exec - so it was not an operating system as such
- Allowed you to submit jobs to the machine and G2+ would schedule them
- Batch programs together into a single job
- Parameterised macros (or JCL – Job Control Language) allowed automation of tasks
- Submit many jobs at the same time so that G2+ would run them one after another

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History of Operating Systems

Operating Systems

**ICL Operating Systems**  
**George 1/2/2+**

- Submit many jobs at the same time so that G2+ would run them one after another
- Adjustable scheduling algorithm (via the operators console)
- Other scheduling factors (e.g. tape decks or memory)
- Under G2+ the operators still look after individual jobs

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**ICL Operating Systems**  
**George 3/4**

- Operators no longer looked after individual jobs. Instead they looked after the system
- Jobs could be submitted via interactive terminals by a scheduling team
- Development staff could issue batch jobs and also runs jobs in an interactive environment.
- Any problems were referred to development or technical staff

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**ICL Operating Systems**  
**George 3/4**

- Operators, in some peoples opinion were little more than "tape monkeys"
- G3 was an operating system in its own right
- To use the machine you had to run the job in a user
- The Job Control Language (JCL) was much more extensive than that of G2+
- It allowed interactive sessions
- It had a concept of filestore

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**ICL Operating Systems**  
**VME: Virtual Machine Environment**

- VME creates virtual machines that jobs run in. If you log onto VME, you will create a virtual machine
- VME is written to cater for the many different workloads that mainframes have to perform
- Job control language (SCL) which is a lot more sophisticated

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### ICL Operating Systems

#### VME: Virtual Machine Environment

- Still concept of filestore – but all disc based
- Amount of filestore available to users or group of users is under the control of the operating system (and thus the technical support teams)
- Like G3, the operators control the entire system
- Move towards lights out working

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### Concepts

#### Processes

- A running program with all the other information that is needed to control its execution
- Process information held in a process table
- Assume we have two (or more) processes that the operating system is dealing with
  - What challenges does this present to the operating system designer?

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### Concepts

#### Processes

- Maintain State
- Scheduling
- Inter-process Communication
- Deadlocks (general problem, not just processes)

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### Concepts

#### Files

- System calls to (for example) create files, delete files, move files, rename files, copy files, open files, close file, read files, write files.
- Files and Directories
- **Abstraction**
  - Text and binary files
  - Standard input and standard output
  - Pipes.
    - DIR | SORT
  - Redirection
    - DIR > dir.txt

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### Concepts

#### Files

- What challenges face the operating system designer when implementing a filing system?

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### Concepts

#### Files

- Directory Structure
- File Types
- File Access (sequential, random)
- File Attributes
- Backup
- Allocation
- Free Space Maintenance
- Maintenance (defragmentation)
- Caching
- Arm movement

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Concepts

Memory Management

- What challenges face the operating system designer when implementing a memory management system?

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Concepts

Memory Management

- Dealing with multiple processes
- How to partition the memory
- How to allocate memory to a process
- How to de-allocate memory
- How/when to re-locate memory
- How to keep track of the memory that is being used and assign to which process
- How to deal with virtual memory

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