Comp 104:
Operating Systems Concepts

Prof. Paul E. Dunne.
Department of Computer Science,
University of Liverpool.

Comp 104:
Operating Systems Concepts

Introduction

Today

- Admin and module info
- Introduction to Operating Systems
  - Overview
  - OS managers

Admin

Lecturer:
Prof. Paul E. Dunne
Room 204, Ashton Building
Email: ped@csc.liv.ac.uk or sq12@llverpool.ac.uk or
P.E.Dunne@liverpool.ac.uk (all work)

Course Notes:
http://www.csc.liv.ac.uk/~ped/COMP104/

Acknowledgement:
thanks to Terry Payne, Katie Atkinson and Dave Jackson for supplying material related to the content of this module.

Module Delivery

- Lecture times and locations:
  - Monday 14:00
    - **Life Sciences Building Lecture Theatre 3**
  - Tuesday 15:00
    - **Life Sciences Building; Lecture Theatre 3**
  - Wednesday 12.00
    - **Chadwick Building Chadwick Lecture Theatre**
- Lab classes: (details to be confirmed)
)
  (check assignment of Spider/Orbit)

5

Module Aims and Objectives

- To create an understanding of how the principal software components of modern computer systems perform their functions, and how they are constructed and interact with each other.
- At the end of the module, students should be able to construct programs which demonstrate in a simple form the operation of examples of systems programs and programs that involve management of concurrent processes.

6

Syllabus Outline

- Operating Systems Concepts;
- Processes;
- Concurrent Programming;
- Memory Management;
- Input/Output and Files;
- Revision.

7

Module Syllabus (Approximate)

- Operating Systems concepts:
  - communicating sequential processes;
  - process management and scheduling;
  - resource allocation, mutual exclusion, semaphores, deadlock.
- Concurrent programming in Java:
  - Java threads;
  - The Producer-Consumer and Dining Philosophers problems.
- Memory Management:
  - storage management systems and their problems;
  - segmentation;
  - paging;
  - page replacement policies.
- Input/Output and Files:
  - filestore organisation;
  - file allocation policies;
  - buffering and caching;
  - device handling.

8

Recommended Texts

- *Operating System Concepts (8th Edition).* Silberschatz, Galvin & Gagne (Wiley)
- *Understanding Operating Systems.* Flynn and McHoes (Thomson)

Lecture notes include material based on examples from all of the above texts

9

Module Assessment

- There is a coursework component that counts for 20% of the final mark for Comp 104.
- The CA component consists of 2 practical (Java-based) exercises that each contribute 10% to the CA component. Details to follow as the module proceeds.
- There is also a 2 hour exam in May which is worth 80% of the final mark.

10

Notes

- **Course webpage**:
  http://www.csc.liv.ac.uk/~ped/COMP104/
- **Printouts** of the lecture notes are available from the computer science helpdesk (George Holt Building).
- **Office hours**: I will (normally) be available for people to come and see me during the following times, but **please email me first** to make an appointment:
  - Tuesday 12 – 2pm
  - Friday 12 – 2 pm

11

Please…

- Switch off all mobile phones during lectures.
- Do not scan the register on behalf of other people.
- Attend lectures, but do not talk during them, and attempt the exercises set.
- Attend the practical classes and complete the coursework.
- Ask questions if there is anything that you do not understand.

12

Operating Systems Concepts

13

Operating Systems

- Purpose
  - To turn base hardware into a usable machine
  - To make efficient use of available resources, particularly when they are shared

14

Examples

- Some operating systems are specific to certain types of computer, while others can run on a range of different designs:
- Windows (developed by Microsoft)
  - designed for Intel processors
- MAC-OS (developed by Macintosh)
  - designed for use only on Macintosh computers
- UNIX and later LINUX (developed by AT&T)
  - designed for a range of computers
- "pre-history" (ie before most of you were born): IBM O/S 360 (mid 1960s); EMAS (Univ. of Edinburgh, mid-late 1970s); VMS (DEC, 1980s)
  - Mainframe/midi multiuser O/S running on single monolithic machine: maker specific – IBM, ICL, etc

15

Has anything changed?

- Idea of simplifying the user environment by having complicated "book-keeping" activity (I/O, file management, program execution, security etc) dealt with "automatically" is 50+ years old.
- In this period there has been a significant shift from environments where standard interaction with computers was "multiple access'' to a single very expensive, "large" facility (hence success of IBM, DEC, Burroughs, ICL) to the, now, standard usage of laptops, netbooks, and single-user personal environments in general.
- It is, thus, patently obvious that the principles of O/S design taught on CS courses in the 1970s are irrelevant to 21st century modules.

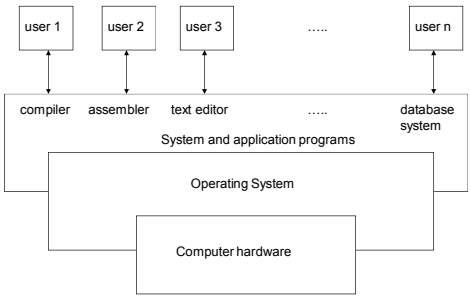
16

Or is it "obvious"?

- In fact, this view is quite incorrect:
  - although the **USER** environment has changed enormously
  - the basic problems (of how to make life "easier" for users) are similar AND
  - the THEORY and SOFTWARE concepts that have been adopted to deal with these.
- Arguably, leaving aside machine specific aspects, the main ideas discussed in O/S design courses from 30-35 yrs ago, have not changed

17

A Computer System



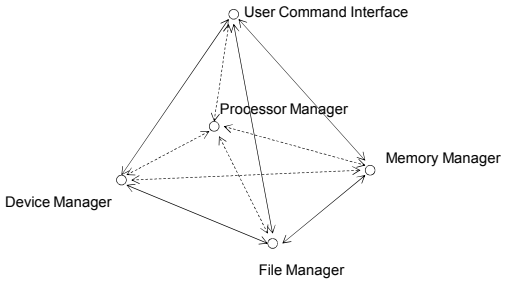
18

Machine Hardware

- OS role is to interact with the essential aspects of the computer system's hardware, the physical machine and its electronic components, which include:
  - Main memory: where data and instructions must reside in order to be processed
  - Input/Output (IO) devices: the peripheral units in the system, e.g., printers, keyboards, CD drives, modems etc.
  - The Central Processing Unit (CPU): contains the circuitry (the chips) that controls interpretation and execution of instructions

19

Operating System – An Abstract View



20

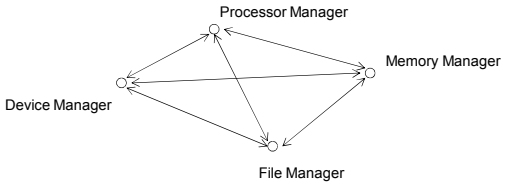
Operating System – An Abstract View

- The base of the pyramid shows the four essential managers of every OS, each working with the others to perform its task:
  - Memory Manager
  - Processor Manager
  - Device Manager
  - File Manager
- Network functions were not always an integral part of an OS
  - A Network Manager can be added to handle networking tasks
- User Command Interface: how users interact with the OS by issuing commands.
  - Varies from one OS to another

21

Operating Subsystem Managers

The base of the pyramid shows the four essential managers of every operating system:



22

Operating System Managers

- Each subsystem manager must perform the following tasks:
  - Continuous monitoring of resources
  - Enforcement of policies that determine who gets what resources, when they get them and how much
  - Allocation of resource when it is appropriate
  - De-allocation of resources when it is appropriate

23

Memory Manager

- Memory Manager: in charge of main memory
- Tasks:
  - Preserves and protects the space in main memory that is occupied by the OS itself
  - Checks validity of each request for memory space
  - For legal requests, allocates a portion of memory not already in use
  - In a multi-user system, must keep track of which users are using which section of memory
  - De-allocates sections of memory that are no longer needed

24

Processor Manager

- Processor Manager: decides how to allocate the central processing unit (CPU)
- Tasks:
  - Handles jobs as they enter the system
  - Manages each process within the jobs
  - Monitors whether CPU is executing a process or waiting for a 'read' or 'write' command to finish executing
  - Once the CPU has been allocated, sets up required registers and tables
  - Keeps track of the status of each process
  - Reclaims the CPU once the job is finished

25

Device Manager

- Device Manager: monitors every device and control unit
- Tasks:
  - Allocates the system's devices (e.g., printers, terminals, disk drives, etc.), in accordance with the system's scheduling policy
  - Must perform this allocation so as to allocate the devices in the most efficient manner possible
  - Once a device has been allocated the manager starts the device's operation and when required, de-allocates the device

26

File Manager

- File Manager: keeps track of every file in the system
- Tasks:
  - Monitors all files, including data files, compilers, application programs etc.
  - Enforces restrictions on who has access to which files (using a pre-determined access policy)
  - Controls what users are allowed to do with the files they can access
  - Allocates the resource by opening the file and de-allocates it by closing the file

27

Interaction Between OS Managers

- Each OS manager has specific, individual tasks to perform
- But, it is not enough for each to operate on its own: each manager must be able to work in harmony with the others
- Example:
  - Suppose a user types in a command at the keyboard to execute a program
- The following (simplified) steps must occur in sequence:

28

Interaction Between OS Managers

- **Device manager**: receives electronic signals from keyboard, decodes keystrokes, sends command to User Command Interface where Processor Manager validates command
- **Processor Manager**: sends acknowledgement message to monitor, determines whether program is already in memory or must be fetched from storage and notifies the appropriate manager
- **File Manager**: calculates program's exact location on disk, if not already in memory, and passes this info to the Device Manager

29

Interaction Between OS Managers cont'd

- **Device Manager**: retrieves the program and sends it on to the Memory Manager which must find space for it and records its exact location in memory
- **Memory Manager**: tracks program's location and progress as it is executed by the Processor Manager
- **Processor Manager**: receives a 'finished' message when the program has finished executing and forwards this message to the Device Manager which displays the message on the monitor

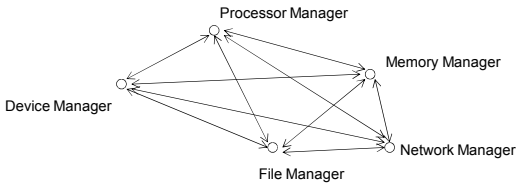
30

Network Manager

- For operating systems that have networking capability there is a fifth manager, the Network Manager, added to the model
- The Network Manager provides the facilities for users to share resources while controlling user access to them
- These resources include
  - Hardware, such as: CPUs, memory areas, printers, disk drives, etc
  - Software, such as: data files, application programs, compilers etc
- Adding this additional manager to our model, our system now looks like this…..

31

Operating System with Network Manager



32