COMP25111: Operating Systems

Before we start: (and before you read the rest of this handout)

What do you think each of these means?

"Computer Architecture"

"System"

"System Software"

"Operating System (OS)"

MANCHESTER
1824
The University of Manchester

COMP25111: Operating Systems
Lecture 1: Introduction

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Overview & Learning Outcomes

Course-unit objectives

Course-unit organisation

Context

Coda: Summary, (Exam) Questions, Your Questions, Glossary, Reading

Computer Architecture theme

"Computer Architecture involves
the selection and interconnection of hardware components
to create computers that meet functional, performance and cost goals."

"As a result,
the development of effective computer architectures
is a central part of technology development, and
an understanding of the capabilities of architectures
is important for developers of higher-level systems."

Course-unit Aims/Outcomes

Principles of operating system design
& implementation techniques
– overall structure & functionality
– interactions with H/W & Apps
– "managers": process, memory, I/O-device, file

Concurrent nature of operating system activities.

Illustrate using two concrete examples (Linux, Windows)

Take more control of your own learning

Contents

Computer Architecture: ISA, Fetch-Execute, (Datapath, Control)

Introduction to OS: purpose, concepts, entities, functions

Processes: Creation, Scheduling, Termination, Communication, Synchronisation, Java Threads

Memory: Basic concepts, Contiguous storage allocation, Single- & multi-programming, Segmentation, Paging

Input/Output Device: Polling, Interrupts.

File Systems: Directory organization, File types & organization

Case Studies: MS Windows, Linux

Why Study Operating Systems?

To understand what really happens in a computer

A case study of how to cope with complexity

Useful algorithms, techniques, concepts (e.g. Concurrency)

Part of leading edge of CS

Module Organisation

Will Toms: william.toms@manchester.ac.uk (lectures 1-7)
Oscar Palomar: oscar.palomar@manchester.ac.uk (lectures 8-10 and 16-18)
Richard Neville: richard.neville@manchester.ac.uk (lectures 2-3 (non-151) and 11-15)

studentnet.cs.manchester.ac.uk/ugt/COMP25111/
Blackboard
(notices, handouts, labs, revision etc.)

2 lectures per week
attend, make notes, try questions, ...
(lecture notes will contain essential information)

Textbooks
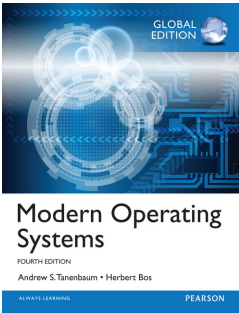
Tanenbaum - Modern
Operating Systems
(4th ed - 2nd or 3rd fine)
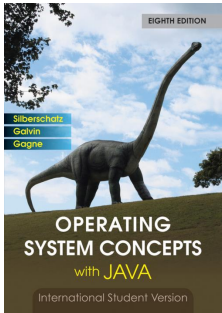
Silberschatz et al. - Operating
System Concepts / with Java
(8th ed)
(more recent editions ok but
avoid older)
Read an OS book

Lab

Ex 1: MU0 Computer Architecture (1 lab session)
Ex 2: Process Scheduler (Java - 2 lab sessions)
Ex 3: Paging Simulation (Java - 2 lab sessions)

(details on website & Blackboard)

1 lab session per fortnight (starts week 3)
& a catch-up marking session (semester 2 week 1)

Start before scheduled session
Get help during session
Submit by 1 working week after the start of your session (except at end of semester 1)
Get marked next session (except at end of semester 1)

MU0 Computer Architecture: lectures 2 & 3, lab 1

Those who took COMP15111 (or equivalent):
– processor design with me (here or Kilburn 1.1)

Those who did **not** take COMP15111:
– low-level programming & execution with Richard (IT407)

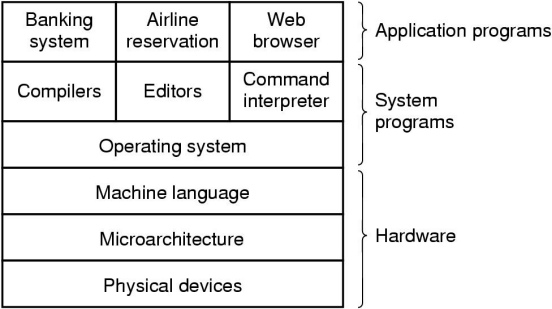Lab introduced in lectures
(done in normal lab groups & rooms)

Definition: System

"A complex whole;

a set of connected parts;

an organized assembly of resources and procedures
united and regulated by interaction or interdependence
to accomplish a set of specific functions."

Definition: Operating System

Intermediary between User/Program & Computer Hardware

Goals:
– run user programs
– make the hardware convenient to use
– use the hardware efficiently

Banking system	Airline reservation	Web browser	} Application programs
Compilers	Editors	Command interpreter	} System programs
Operating system			
Machine language			} Hardware
Microarchitecture			
Physical devices			

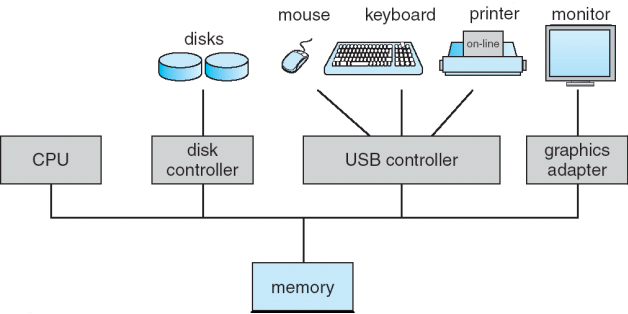## An OS can be viewed as ...

The software that is always loaded/running

A Resource Manager

A Virtual Machine

A Service Provider

Resources that need Managing

Technology

Moore's Law: Number of Transistors Doubles Every Two Years

Intel Skylake: 14nm node, Apple A10: 16nm

Covalent Radius of Si: 110pm

Wavelength of Visible Light: 248nm to 193nm

Moore's law slowing down: Intel's 10nm pushed back to 2017

Technology

Relative Speeds:

Intel Skylake i7-6700K: 207.23 GIPS

DRAM DDR4-3200: 25.6 GB/s

PCIE 3.0 (1 lane): 985 MB/s

4TB HDD: 229MB/s

Wifi (80211.ac): 330MB/s

Q

If a computer has a 3GHz clock:
– how far can an electronic signal go in 1 clock cycle?
– how many clock cycles while a 7200 rpm hard disk rotates 360 degrees?
– how many clock cycles between characters typed quickly on a keyboard?

How long is 10^6 seconds?
How long is 10^9 seconds?

OS evolution

At first: 1 user, 1 program, 1 computer (no OS)

Computers rare & expensive → improve utilisation

Batch OS: run a series of programs, one-at-a-time

Do 3 things at once: input $prog_{n+1}$ & run $prog_n$ & output $prog_{n-1}$

In what order? - multiprogramming

Time-sharing: multi-user on-line access

OS Drivers

Multiple users/programs, so need:
– (efficient) sharing of resources
– protection

Changing objectives: Capacity → Features → Ease of use

Technology:
- memories & peripherals get bigger and more complex
- CPU clock speeds $>>$ memory & peripheral speeds

OS Diversity

Multiprocessor (parallel computing) OS

Distributed OS

Real-time OS: must respond within deadline
– "hard" real-time: failure if system doesn't respond on time
– "soft" real-time: missing some deadline is acceptable

Embedded OS

PC OS

Summary of key points

Objectives: Theme, Aims/Outcomes, Contents, Motivation

Organisation: Staff, Web, Lectures, Labs, Books

Context: Definitions, Views, Evolution, Drivers, Diversity

OSs provide Services = Interface to Managed Resources
– Sharing
– Protection
– Concurrency
Goal: Efficient & Convenient use of Hardware

Next Lecture: Remember to **split**

Your Questions

Write down **your** questions – things you missed, things you didn't quite understand, things you disagree with, or just things you would like to know more about.

Try and answer them yourself, or with friends, or ask me (e.g. via email, or in a lab, or just before the next lecture starts)

For next time

Exam questions – try them for next lecture (after split)

A complete OS may contain managers for devices, network, filestore, memory, & processes. Which of these would you expect to be present in an OS for:
– A process control computer with a sensor for monitoring, an actuator for control, and a network connection for reporting to and receiving commands from a control centre?
– A dedicated, network-based filing machine or "file server"?
– A computer dedicated to controlling the communications passing between two networks; that is, a "gateway"?
– An autonomous lap-top personal computer?
– A single-user workstation with services available across a network?
– A machine dedicated to managing and answering queries on a database?

Exam Questions

More exam questions – try them whenever you want

One reason GUIs were initially slow to be adopted was the cost of the hardware needed to support them.

– How much video RAM is needed to support a 25 line * 80 row character monochrome text screen?
– How much for a 1024 * 768 pixel 24-bit color bitmap?
– What was the cost of this RAM at 1980 prices ($5/KB)?
– How much is it now?
[MOS, ex.7, Ch.1]

Exam Questions ctd.

How many clock-cycles happen on a 3GHz processor

– in a millisecond?
– during an Ethernet network transfer of 512 bytes at 100 Mbits/sec?
– during a typical transfer of 1k bytes to a disk with a 10 ms seek time, 7200 rpm rotation speed, and a transfer rate of 300 Mbytes/sec?
– sending a packet to a computer in New Zealand and waiting for the reply?
(the radius of the earth is approx 7800 km, the speed of light is approx $3x10^8$ m/s, New Zealand is approximately opposite England on the Earth's surface)

For each of your answers, how long is that many seconds?

Glossary

More possible exam questions: "Define ..." or "Briefly explain ..."

Computer hardware (H/W):
Computer software (S/W):
Computer architecture:
Input-output (I/O) device:
System software:
Operating System (OS):

Computer clock:
A clock cycle:
Hz:

k, M, G, T:
m, μ, n:

Reading

MOS-2: §1.1, 1.2, 1.3 (pages 1-20)

MOS-3: §1.1, 1.2, 1.4

OSC/J: §1.1, 1.2, 1.3, 1.11, 1.12