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)”

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

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

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\(_n\) & 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

**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?

**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)
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 3\times10^8 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