OS - Retrospection

Tid-bits from course outline
This course is oriented towards exposing students to the essential concepts and issues that underly operating systems and their design.

• Technical
  • Make students understand the key concepts and mechanisms of modern operating systems:
    • processes and process management,
    • memory management techniques,
    • on-line storage methods (file systems),
    • concurrency issues.

• Educational
  • Make students understand the reasons why operating systems are built the way they are, and what the implications and lessons are for other software systems. Specific learning objectives are:
    • appreciation of design trade-offs and design decisions and their dependence on the target
    • exposure to low-level code
    • exposure to current trends in operating systems research and development.

• Professional
  • The tutorial formats will give students practice in the presentation of solutions to an audience of peers, and will challenge them to critique peer technical presentations. Furthermore, the assignments give students an opportunity to develop skills required to work as a team on a technical project, and the opportunity to work with a substantial body of code created by a third party.

Operating Systems @ CSE.UNSW

Systems Courses
• COMP9242 Advanced Operating Systems
  – In-depth coverage of OS implementation issues
  – Learn what makes OS fast and what makes them slow
  – Learn how the OS deals with multiprocessors, caches, ...
  – Write your own OS
• In Session 2 taught by Prof. Gernot Heiser and Dr. Kevin Elphinstone

• Distributed systems COMP9243
  – Examines issues in building distributed systems and infrastructure
  – Peer-to-peer, web services, network file systems, name services, ……

OS Research
ERTOS Group - NICTA

– 4 FTE researchers (PhDs)
– 4 FTE research engineers / research assistants
– 6 PhD students
Operating Pillars

- Established on:
  - Research – Built on exceptional research talent
  - Education – Built on enhancing ICT education
  - Commercialisation – Built on consideration of use
  - Collaboration – Built on exceptional partnerships

The Problem

- Enormous complexity of embedded systems software
  - 5–7Mloc on smartphones
  - Gigabytes of software on cars

Challenges

- Complexity increasing even in life-critical systems
  - GUIs on medical devices
  - Integration of infotainment and control functions in cars
Challenges

- Mutually untrusted software vendors
- No longer closed systems
  - Download software
- Connectivity
  - Attacks from outside

General-Purpose Vs. Embedded

- Traditional View:
  - General Purpose System
    - Applications
    - Virtual Memory
    - Device Drivers
    - Hardware
  - Embedded System
    - Applications
    - Hardware
    - Device Drivers
    - Hardware
    - Connectivity
- Attacks from outside
- minimal
- no protection

Embedded Systems Software

Present Approaches 1: Real-time Executives

- Small, simple operating system
  - optimised for fast real-time response
  - suitable for systems with very limited functionality
- No internal protection
  - every small bug/failure is fatal
  - no defence against viruses, limited defence against crackers

Embedded Systems Software

Present Approaches 2: Linux, Windows Embedded

- Scaled-down version of desktop operating system
  - operating system protected from application misbehaviour
  - excessive code base for small embedded system
  - too much code on which security of system is dependent
- Dubious or non-existent real-time capabilities
  - unsuitable for hard real-time systems

Linux Kernel Evolution

For reference:
Linux 2.4.18 = 2.7 million lines of code

Our Approach: Microkernels

- Extremely small kernel
  - microkernel only contains code that must run in privileged mode
  - all other "systems" code runs as unprivileged servers
  - microkernel protected from application and other systems code
  - microkernel provides protection of all components from each other
  - services can be restarted
Microkernel Approach – L4

- Small trustworthy foundation
  - Applications:
    - Fault isolation
    - Fault identification
    - IP protection
    - Modularity
  - High assurance components in presence of other components
- Provides a trustworthy foundation

L4 (UNSW/NICTA) Impact

- Licensed to OK-labs
  - NICTA spinout
  - L4 on 30% of 3G Handsets
    - Including Android/Phone

Why am I telling you this?

Does the following Interest you?

- Gaining in-depth experience in OS research
- Working on a very challenging projects
- Collaborating closely with active researchers
- Getting a high thesis mark
- International travel
- Fame and fortune

NICTA’s Clarinet Playing Robot

- Winner of 2008 ARTEMIS orchestra competition

Prerequisites

- Keen interest in OS
- Demonstrable background/ability in OS
- Sharp Intellect
- Committed to working on a project
Still Interested?

• Check out http://www.ertos.nicta.com.au/
specifically the education section.

On-line Course Surveys

• The on-line course survey will be available
  – My one – in addition to CATEI one
• Please make time to do it
  – Please do the CATEI one as well
• Award 2 bonus marks to everyone who completes my survey.
  – You will be emailed an invite

Final Exam

• Friday, 19th June, 1:45 – 4:00
• Two Hours
• No examination materials allowed
  – Uni approved calculators okay
• Don’t trust me – check the timetable yourself

Exam Format

• 6 questions
  – 4 should be answered in separate books
  – 1 must be answered on the exam paper itself.
  – 1 must be answered on the multiple choice answer sheet provided
  – 100 Marks in total
  – 2 bonus marks for following exam instructions

Exam Format

• Q1 is multiple choice (20% marks)
  You will receive one mark for each correct classification,
  and lose one mark for each incorrect classification.
  You gain zero marks for each answer left unclassified. The overall mark for this question will not be negative, i.e. the minimum mark is zero.

Exam Format

• Q2..Q6, roughly:
  – half working out a solution to a problem
  – half written answers to a question
For written answers
• Be clear and concise (get to the point quickly)
  – Long, rambling answers will be penalised

Sample Question
• Name and four disk arm scheduling algorithms, and give an advantage or disadvantage of each of them.

• Sample Marking Scheme (out of 8)
  – 2 Marks for each algorithm (1 for the name, 1 for the pro/con)

Reasonable answer
• FCFS, SSTF, SCAN, C-SCAN
• FCFS does not take into account head position, may move head excessively, especially in the case of concurrent applications accessing disk (deteriorates to random). Advantage is that it is fair.
• SSTF reduces head movement by choosing request with shortest seek time first, but may result in starvation of distant requests (e.g. if a request is always available nearby)
• SCAN/Elevator better than FIFO, and avoids starvation, but does not take advantage of sequential locality on the down scan
• C-SCAN like SCAN, except avoids disk access on the down-scan and hence improves support for sequential locality

Dumb answers
• FIFO, Clock, EDF, and Two-level scheduling
  – Don’t just as add acronyms you can remember

Answer the question!!!
• Don’t repeat the question, we set the exam, we know what it is!!!!
• Don’t just write what you know (or don’t know) about the topic area
  – You make us have to search for the real answer.
  – You may be correct, but say a lot of unrelated incorrect stuff.
• Don’t contradict yourself
  – X is better/faster/more efficient than Y, and later Y is better than X
• Marks are awarded for stating WHY an answer is correct.
  – Demonstrates understanding
Exam Content

• For structure and style, look at the sample exam from past years.
• For content, the tutorial questions are a reasonable guide.
• Will be releasing 100 sample questions (with student answers).

The questions attempt to examine understanding rather than particular implementations

• Don't expect
  – “Describe OS/161’s exception handling on a timer interrupt”
• But you may get
  – “Describe (in general) a feasible sequence of steps that occur in response to a timer interrupt that results in the current process being pre-empted and a new task running”

Examinable Content

• All Lectures, Tutorials, Assignments.

Consultations

• To be announced