CSE 333

Lecture 22 -- wrapup

Hal Perkins

Department of Computer Science & Engineering

University of Washington

Administrivia

Final exam Wednesday, here, **8:30 am**

- Review Q&A Tuesday, 4:30, EE 045
- Topic list and old exams on the web
- Course overview today

So what have we been doing for the last 10 weeks?

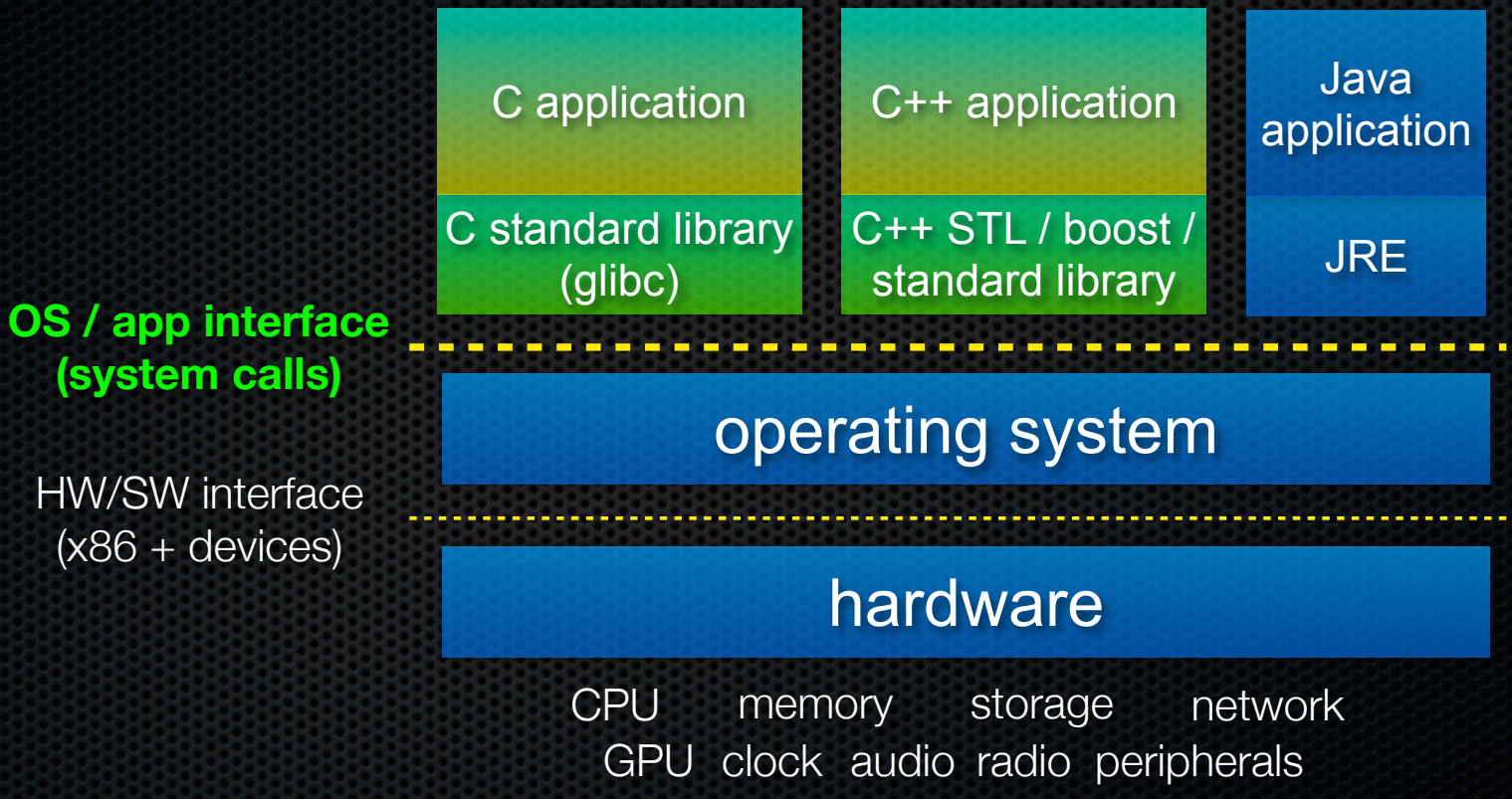
?

Course goals

Explore the gap between

- Intro: the computer is a magic appliance that runs programs
- CSE 351: the computer is a stupid appliance that executes really, really simple instructions

Course map: 100,000 foot view



Goals

Skills

- Programming closer to the hardware: C/C++
- Disciplined design, testing, debugging

Knowledge

- OS interface and semantics, languages, some networking
- A deep understanding of “the layer below”
  - *quiz: when is the data safely on disk after a write? Actually received over the network? How many copies are made along the way?*

Main topics

C Programming, tools, and workflow

Memory management

System interfaces and services (files, etc.)

C++ : the 800-lb gorilla of programming languages

- "better C" + classes + STL + smart pointers + ...

Networking basics: TCP/IP, sockets, ...

Drilling deeper...

The C/C++ Ecosystem

System layers: C/C++, libraries, operating system

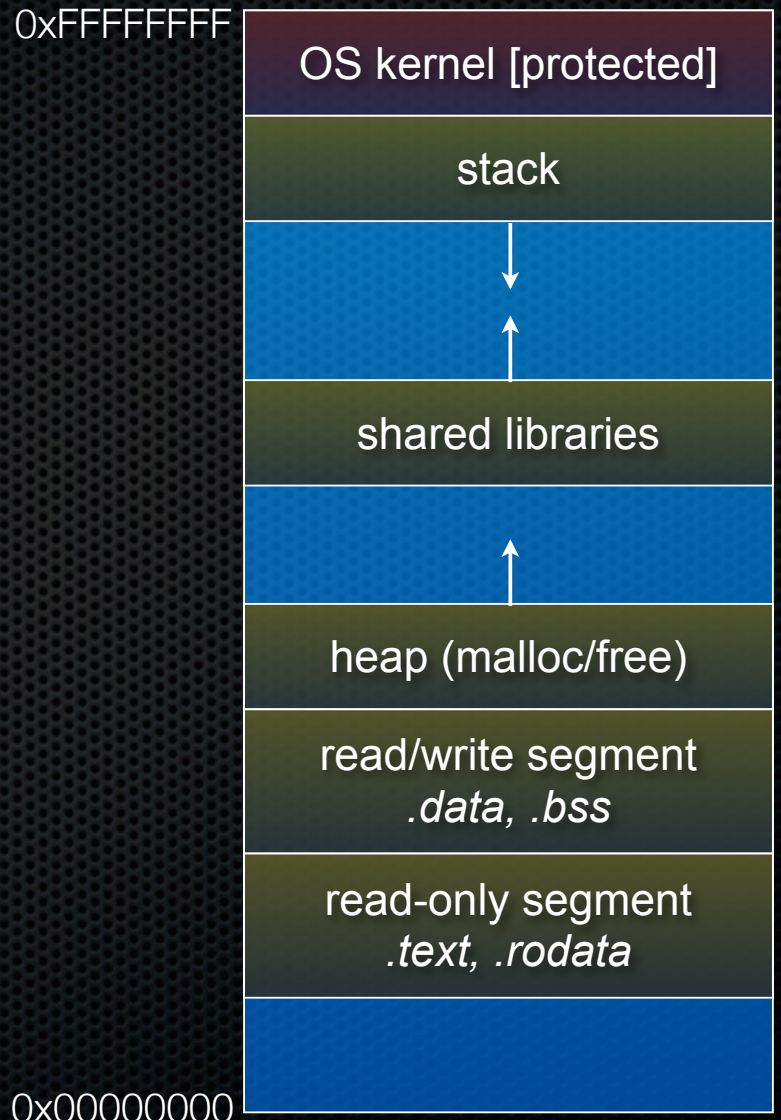
Building programs

- cpp: #include, #ifndef, and all that
- compiler (cc1): source -> .o
- loader (ld): .o -> executable

Program execution

What's a process?

- Address space
- Thread(s) of execution
- Environment (arguments, open files, ...)



C language

Structure of C programs

- Header files and implementations; declaration vs definition
- Internal vs external linkage
- Standard types and operators (scalars including things like uint64_t, structs, arrays, typedef, etc.)
- Functions: defining, using, execution model
- Standard libraries and data structures (strings, streams, ...)
  - C standard library, system calls, and how they are connected
- Handling errors in a language without exception handling
  - return codes, errno, and friends

Memory

Object scope and lifetime (static, automatic, dynamic)

Pointers and associated operators (&, *, ->, [ ])

- Using pointers for call-by-reference as well as linked data

Dynamic memory allocation (malloc/free; later new/delete)

- Who is responsible for dynamic memory & what happens if it's not done right (dangling pointers, memory leaks, …)

Tools: debuggers (gdb), monitors (valgrind), …

- Most important tool: thinking(!)

C++

A “better C”

- Type-safe streams and memory mgmt (new, delete, delete[ ]), etc.

References and const

C with classes (and objects)

- Constructors, copy constructor, destructor, assignment

Subclasses and inheritance

- Dynamic vs static dispatch & why it matters, virtual functions, vtables
- Pure virtual functions and abstract classes

C++ casts - what are they and why so many (compared to C)?

Templates, STL, and smart ptrs

Templates: parameterized classes and functions

- How the idea is similar to Java generics and what's different
- How C++ implements templates (expansion)

STL: basic vector, list, map containers and iterators

- Copy semantics

Smart pointers: unique, shared, and weak

- Reference counting, resource management

Using class heirarchies with STL

- Pointer vs value semantics, assignment slicing

Networking

Layered protocol model, particularly TCP and IP

- What they do, how they are related, how they differ

Networking addresing and protocols: IP addresses, DNS, IPv4, IPv6, ports

Application protocols: where HTTP fits in the scheme

Network Programming

Client side

1. get IP address / port
2. create socket
3. **connect** socket to server
4. **read** / **write** data
5. **close** socket

Server side

1. get IP address / port
2. create socket
3. **bind** socket to address / port
4. indicate that socket is a **listener**
5. **accept** connection from client
6. **read** / **write** data
7. **close** socket

Concurrency

Why?

- Better resource utilization
- Better throughput

Processes

- Heavyweight, isolated, created by cloning: fork( )

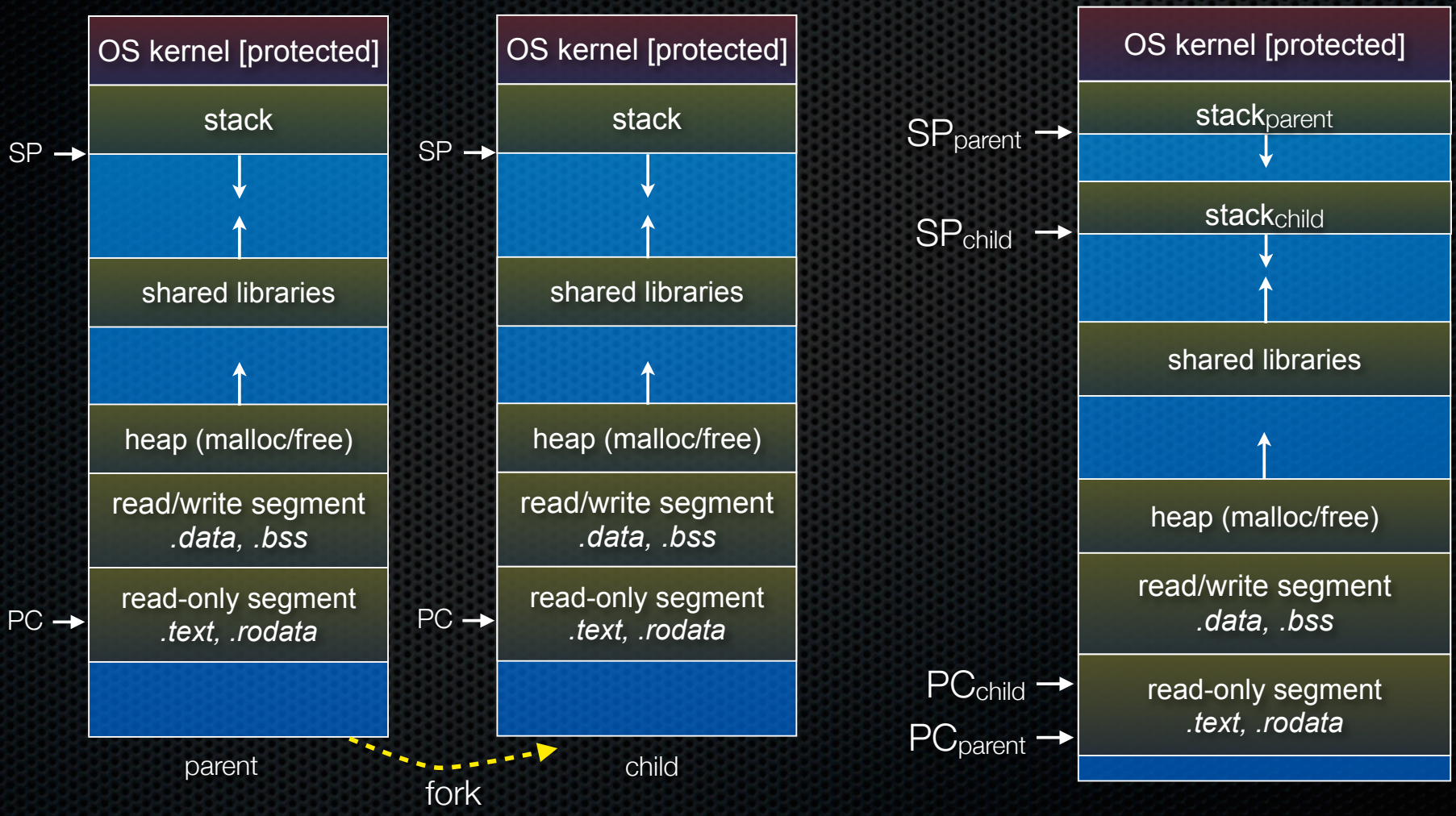
Threads

- Lightweight, share address space, pthreads

Synchronization (particularly threads)

- What are the main issues

Processes vs threads on one slide



Phew! That's it!!

But that's a lot!!!

Studying for the exam

- Review lecture slides, assignments, exercises
- Try some of the end-of-lecture problems for practice
- Look at old exams and topic list on the web
- Study groups! Ask questions / trade ideas on the discussion board! Ask course staff questions
- The goal is learning and mastery

That's it (almost)

Congratulations and good luck on finals!!

And a big thanks to Bryan, Graham, Soumya & Sunjay

- This doesn't happen without great help

And one last thing - course evals

- Constructive feedback (positive we hope, but negative when called for) is what helps us get better

You've learned a lot – go out and build great things!!!

Have a great summer!