CSE 333 – SECTION 10

Final Review

Administrivia

- Final exam March 15th (Wednesday)
- 80 mins(subject to change)

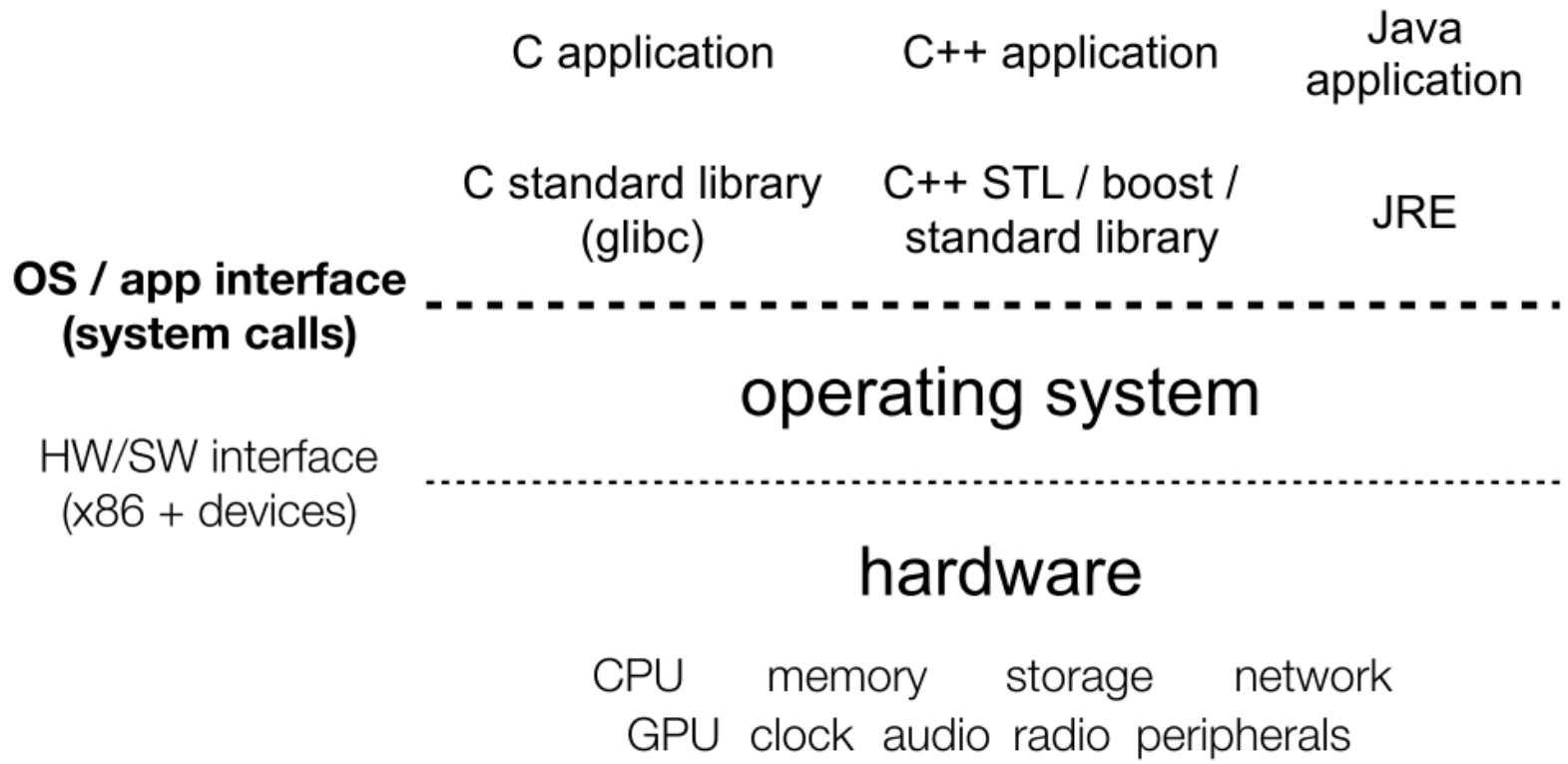
- Hw6 in-person grading will be held on Monday & Tuesday

Overview

- C Programming, tools, and workflow
  - Compilation, linking, runtime
- Memory, types, conversions
- System interfaces and services (file I/O, etc.)
- C++ :
  - “better C” + classes + STL + smart pointers + ...
- Networking basics: TCP/IP, sockets, ...

The C/C++ Ecosystem

- System layers: C/C++, libraries, operating system
- Building programs
  - cpp: #include, #ifndef, and all that
  - compiler: source → .o
  - loader (ld): .o + libraries → executable
- GCC: The C multitool
- Make and related tools to automate the process


C application
C++ application
Java application
C standard library (glibc)
C++ STL / boost / standard library
JRE
OS / app interface (system calls)
operating system
HW/SW interface (x86 + devices)
hardware
CPU
memory
storage
network
GPU
clock
audio
radio
peripherals

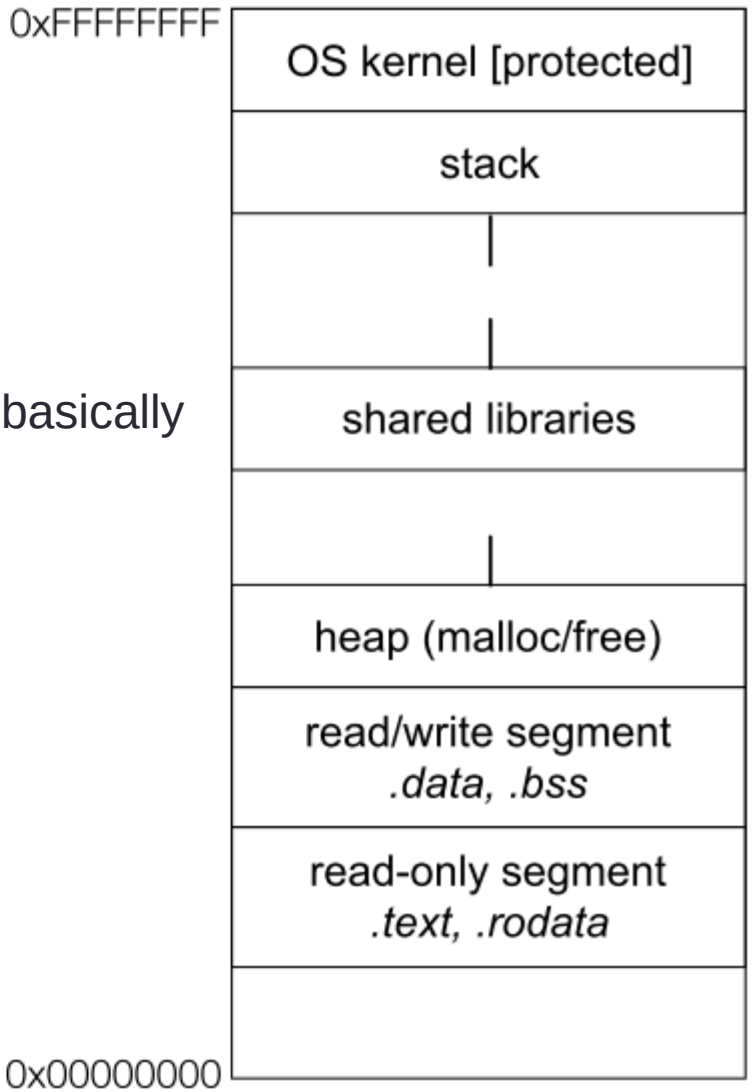
Program execution

What's a process?

A process is basically a program in execution.

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

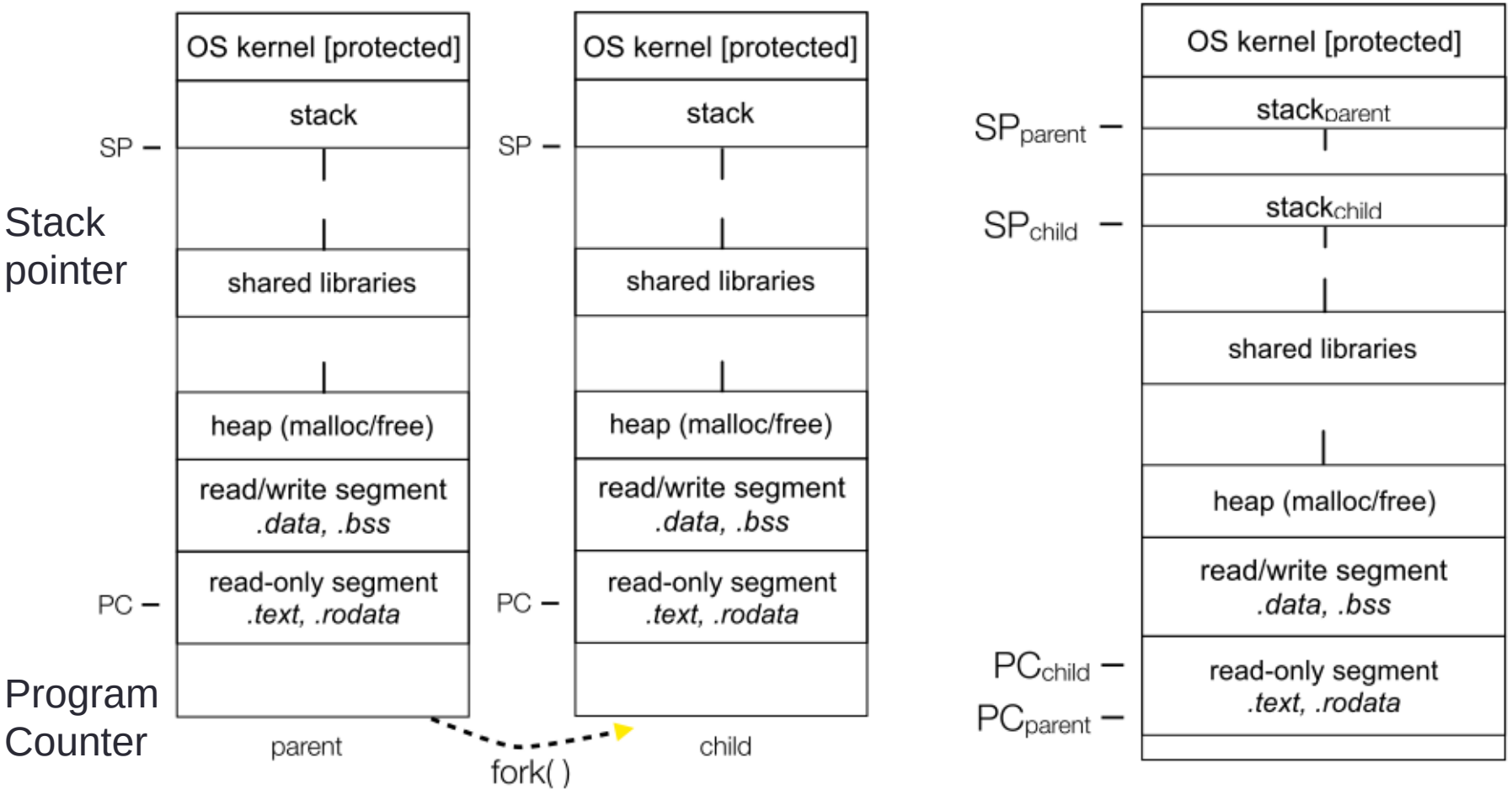
When a program is loaded into the memory and it becomes a process, it can be divided into four sections — stack, heap, text and data.



- How to clone processes?
- Fork() - What is actually inherited?
- - new pid
- - file descriptors are the same
- - Context is the same
- - VM is copied

- FIFO, pipe, etc
- Threads: concurrent execution inside a single process; know a few of the pthread basics (how to create a thread and start execution in a function)
- Processes vs. threads
  - Threads are used for small tasks, whereas processes are used for more ‘heavyweight’ tasks – basically the execution of applications.
  - Another typical difference is that threads (of the same process) run in a shared memory space, while processes run in separate memory spaces.

Processes vs threads on one slide



C language

- Structure of C programs
- - Header files and implementations; declaration vs definition
- - Internal vs external linkage (extern/static)
- - Standard types and operators (scalars including things like uint64_t, structs, arrays, typedef, etc. E.g. structs – how to define and use, meaning of p->x (= (*p).x)
- - 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 (&, *, ->, [ ])
- Dynamic memory allocation (malloc/free; new/delete)
  - Who is responsible for dynamic memory & what happens if not done right (dangling pointers, memory leaks, ...)
- Tools: debuggers (gdb), monitors (valgrind), ...
- - Most important tool: logics & thinking(!)

File I/O

- fread, fwrite, fopen,fclose,fflush, etc.
- read, write, open, close, etc.
- buffer

C++ (and C++11)

- A “better C”
- - Type-safe streams and memory management (new, delete, delete[ ]), etc.
- References and const
- Classes (and objects)
- - Constructors, copy constructor, move constructor destructor, assignment
- Subclasses and inheritance
- - Dynamic vs static dispatch, virtual functions, vtables
- - Pure virtual functions and abstract classes
- C++ casts - static_cast, dynamic_cast, const_cast, reinterpret_cast

C++ (and C++11)

- Templates: parameterized classes and functions
  - How C++ implements templates
  - *How the idea is similar to Java generics and what's different
- STL, containers and iterators.
  - vector, list, map
- Smart pointers, using with STL.
  - unique_ptr (cannot be copied, but can move ownership to another)
  - shared_ptr (reference counting)
  - weak_ptr (used to break cycles)

Network Programming

- Basic network layers: physical, data link, IP, TCP, application
  - Particularly IP and TCP
  - What they do, how they are related, how they differ
- Packets, and packet encapsulation across layers
- IP addresses, address families (IPv4, IPv6), DNS, ports
- Stream sockets, file descriptors, read, write
- Client steps:
  - address resolution, create socket, connect socket to server, read/write (including retries), close
- Server steps:
  - determine address and port, create socket, bind socket to address/port, listen (and how the OS queues pending connections), accept connection, read/write, close

Recources

- Review lecture/section slides, assignments, exercises
- Look at topic list on the web
- Try the Practice Exercises