CS 206

Lecture 14 – Exception handling wrap, Type Systems

Events and Handlers

- An *event* is something to which a running program (a process) needs to respond, but which occurs outside the program, at an unpredictable time
  - Example - GUIsystem: keystrokes, mouse motions, button clicks
  - Network operations – packet arrival, completion of disk I/O
- Synchronous I/O operations unacceptable in modern systems – **why**?
- Instead you want a *handler* —a special subroutine
  - Handler is invoked when a given event occurs.
  - Also known as *callback* functions
    - The run-time system “calls back” into the main program instead of being called *from* it

Thread Based Handlers

- In most contemporary languages, events are handled by a separate thread of control, rather than by subroutine calls
- ***Can the input allowed to be synchronous in thread based handler?***
- If the program wishes to be able to handle multiple events concurrently, it may create multiple handler threads
- Most GUI systems are thread based
  - OpenGL Utility Toolkit (GLUT), GNU Image Manipulation Program (GIMP) Tool Kit (Gtk), Java Swing library

Sequential Handlers

- The language run-time library has a block of code called the *signal trampoline*.
- It also includes a buffer ***writable*** by the kernel and ***readable*** by the runtime.
- Before delivering a signal, the kernel places the saved state of *P* into the shared buffer.
- It then switches back to *P*'s user-level stack and jumps into the signal trampoline.
- The trampoline creates a frame for itself in the stack and then calls the event handler using the normal subroutine calling sequence.
- When the event handler returns, the trampoline restores state (including all registers) from the buffer written by the kernel, and jumps back into the main program.
- To avoid recursive events, the kernel typically disables further signals when it jumps to the signal trampoline.
- Before jumping back to the user program, the trampoline performs a kernel call to re-enable signals.
  - Depending on details of OS, the kernel may buffer some modest number of signals while they are disabled, and deliver them once the handler reenables them.