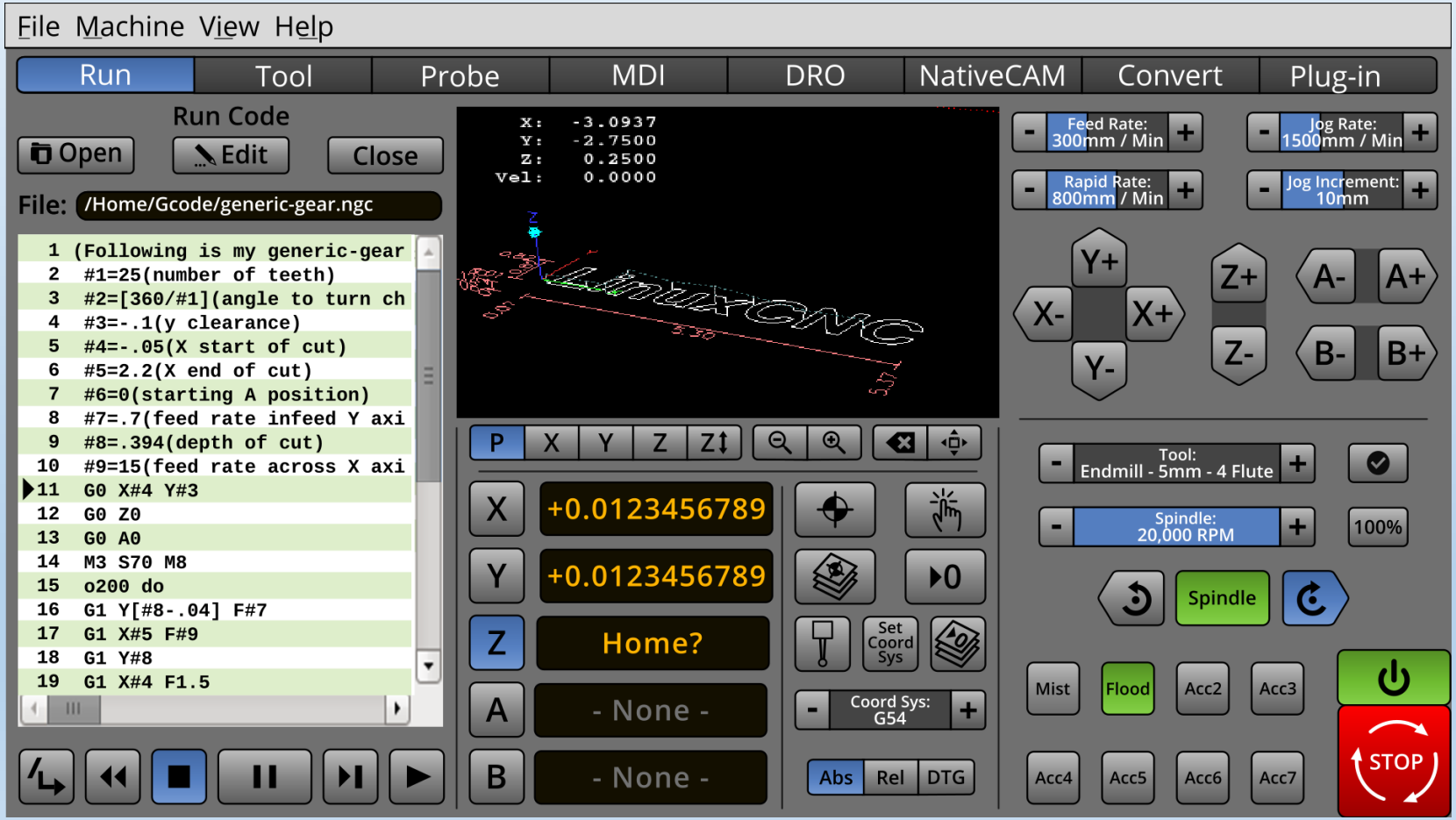
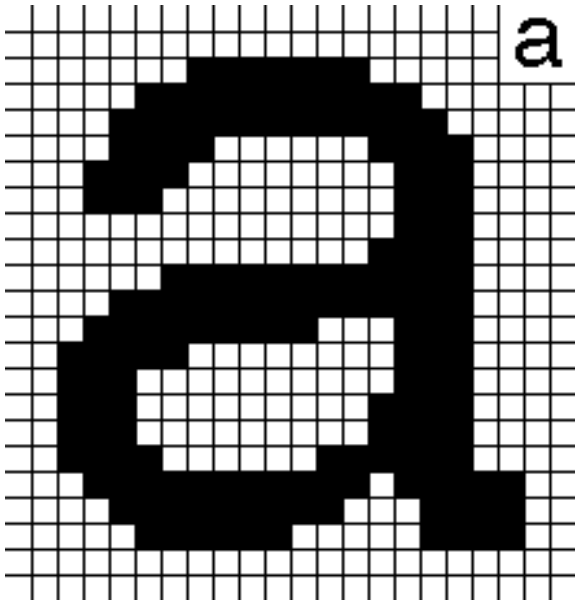
Graphical User Interface



Chapter 20

Early Monitors : Text based



- CPU writes a string of characters to the monitor
- Monitor is like a teletype:
  - New characters are written in order on the bottom line of the screen
  - When the bottom line fills up, scroll the screen up one line
- Each character is converted to pixels by the font library built in to the monitor
  - Each character is a rectangular matrix of pixels

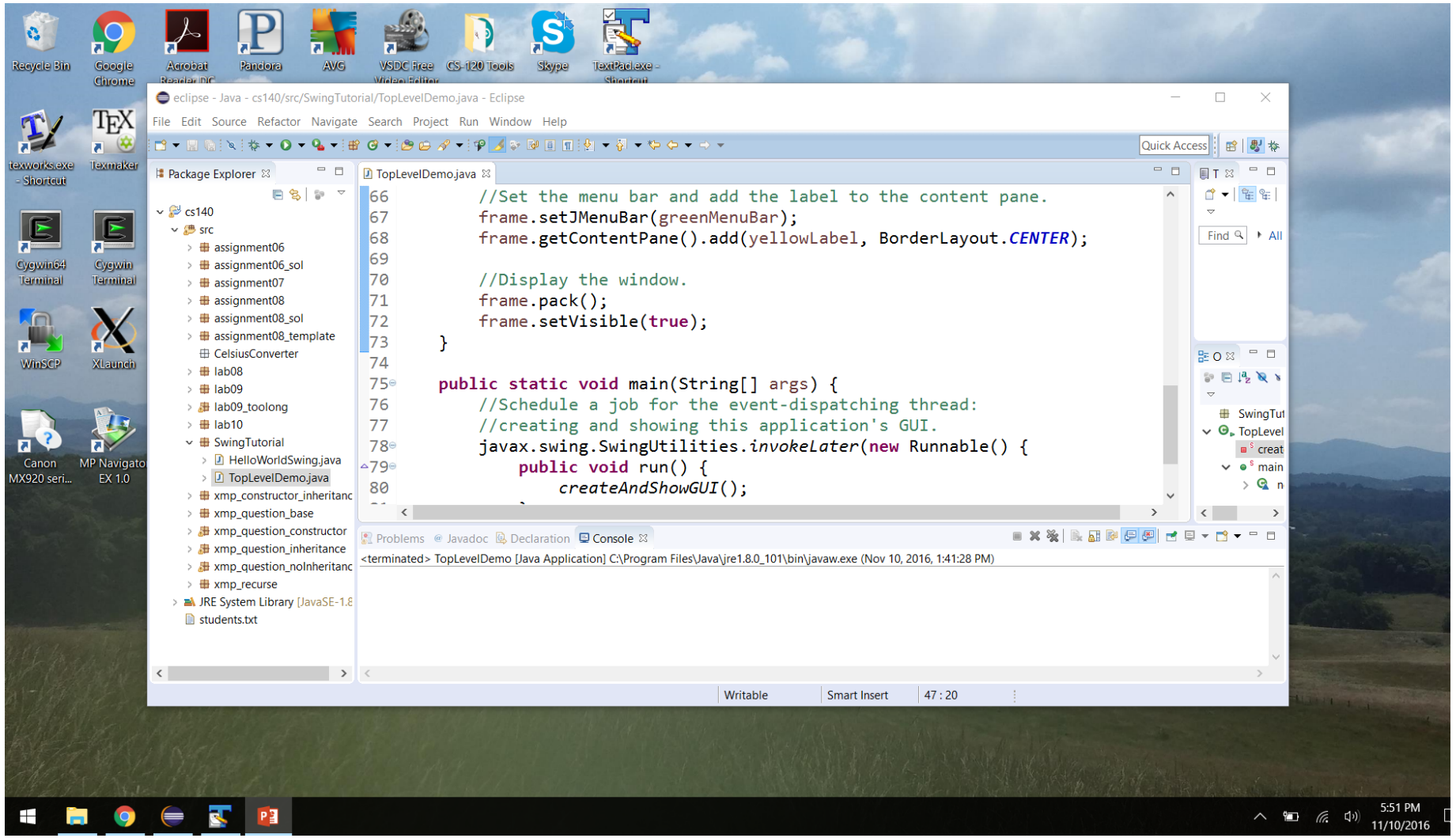
Modern Graphics Basics

- Software controls the entire screen
- Your screen is a two dimensional array of pixels
- Think of each pixel as having an (x,y) coordinate
- The upper left hand side of the screen is (0,0)
- The X axis increases from left to right
- The Y axis increases from top to bottom

(0,0) X (1920,0)

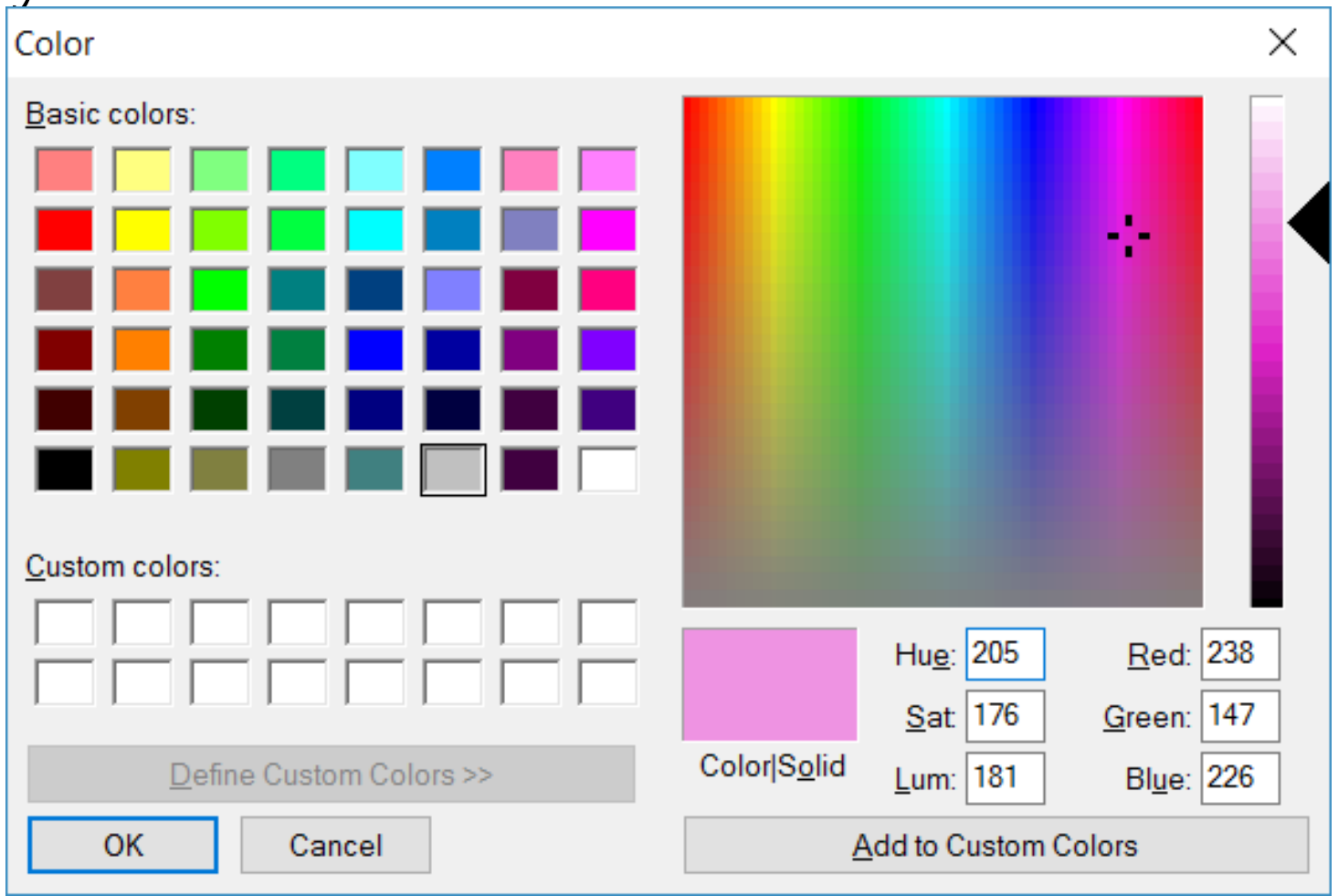
Y

(0,1080)



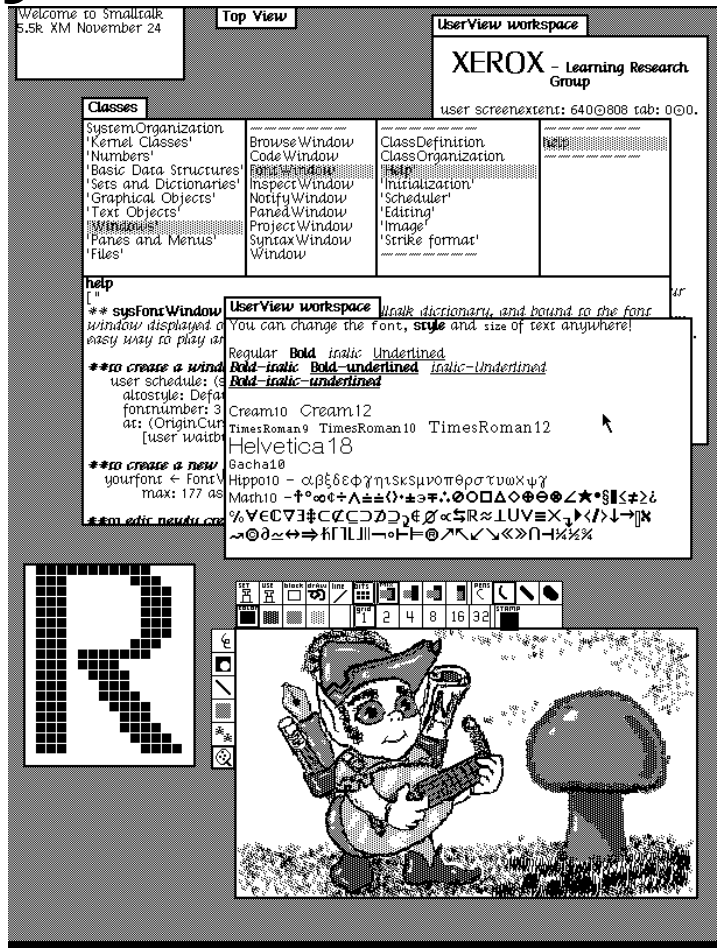
Single Pixel

- Each pixel is described by three numbers 0-255
  - Amount of Red
  - Amount of Green
  - Amount of Blue
- Higher numbers are brighter
  - Black is 0,0,0
  - White is 255,255,255



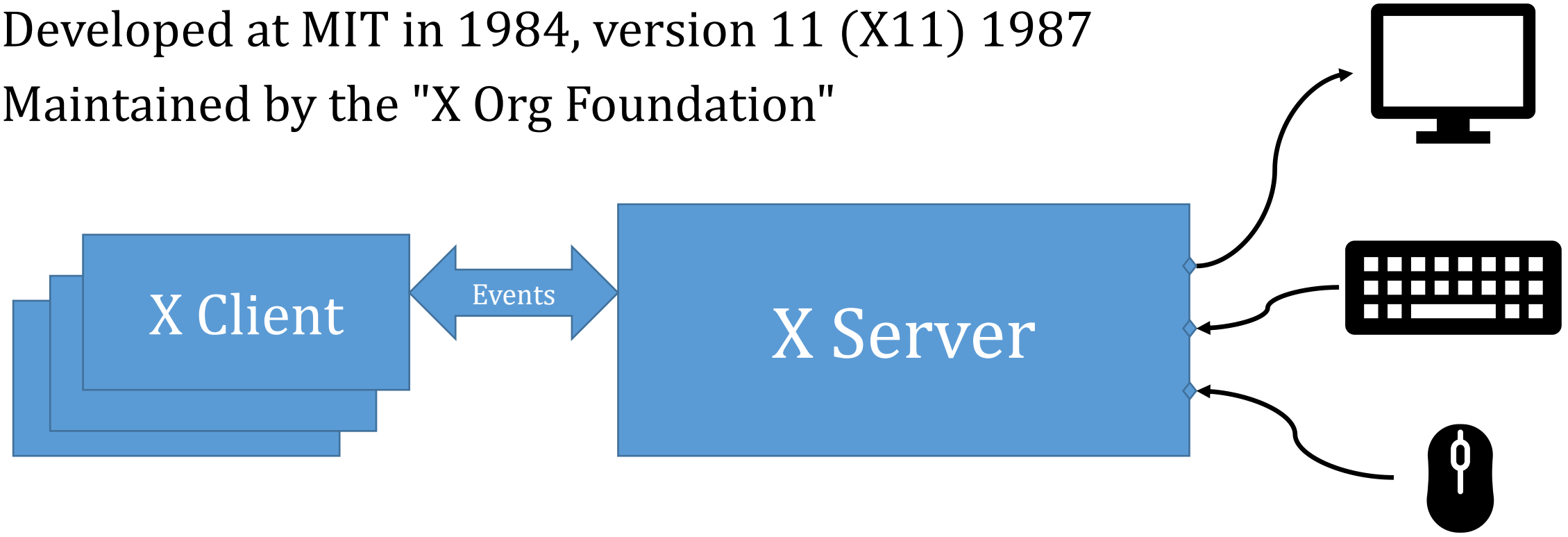
Graphical User Interface History

- Introduced in the 1960s
- Refined and implemented in early 1970 by Xerox
  - Palo Alto Research Center (PARC)
- "WIMP" paradigm
  - Windows, Icons, Menus, Pointers
- Xerox not interested
  - Demo to Steve Jobs and Bill Gates among others
  - Apple Lisa (1983)
  - Microsoft Windows (1985)



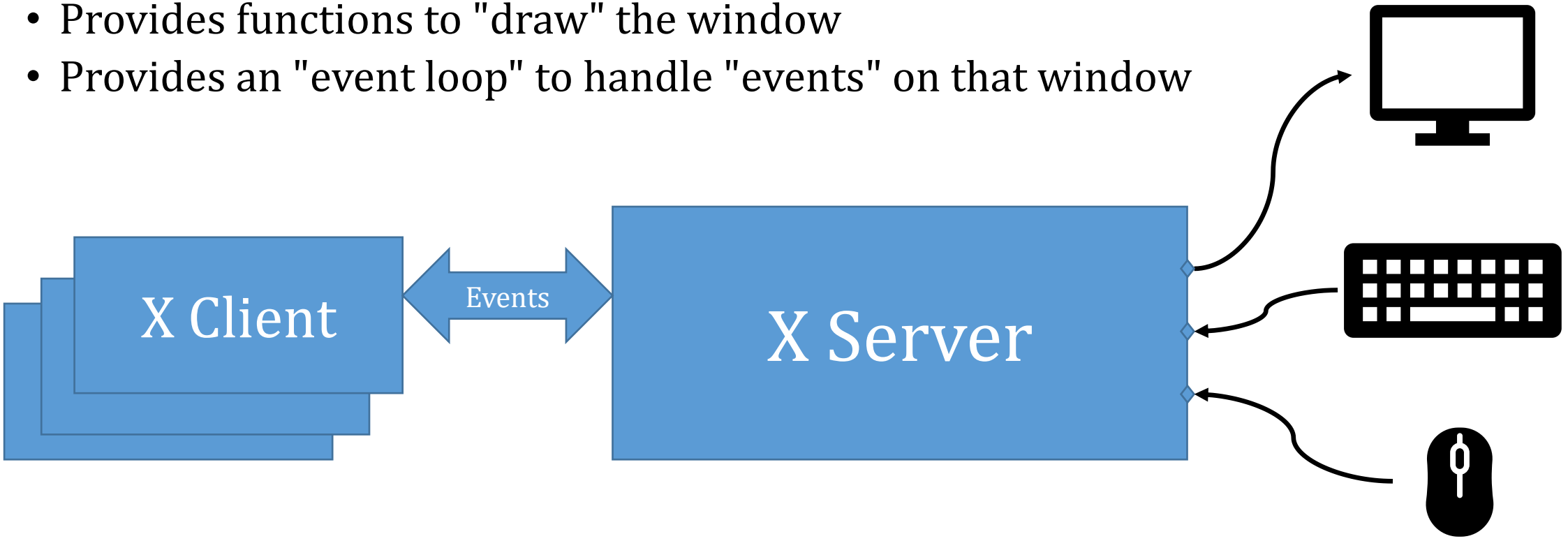
X Window System (X11)

- A platform independent layer of open-source software used to manage monitors
- Developed at MIT in 1984, version 11 (X11) 1987
- Maintained by the "X Org Foundation"



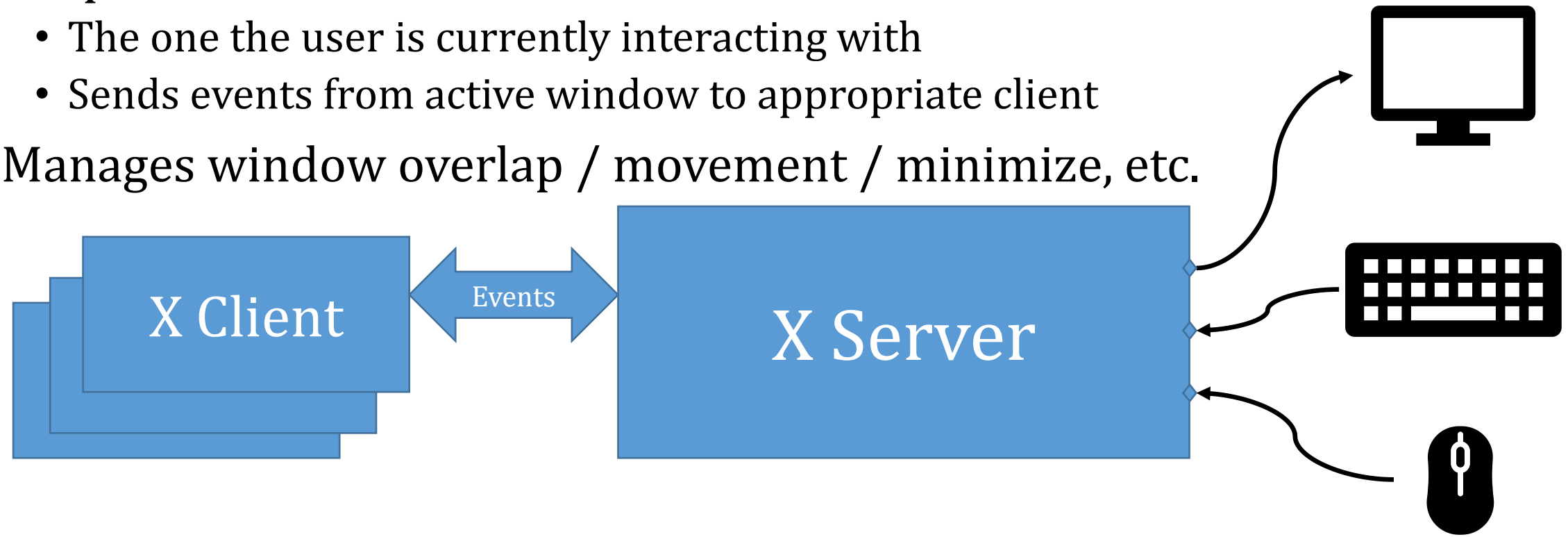
X Client Startup

- X Client asks for a window on the screen
  - Defines what "widgets" go on that window
  - Provides functions to "draw" the window
  - Provides an "event loop" to handle "events" on that window

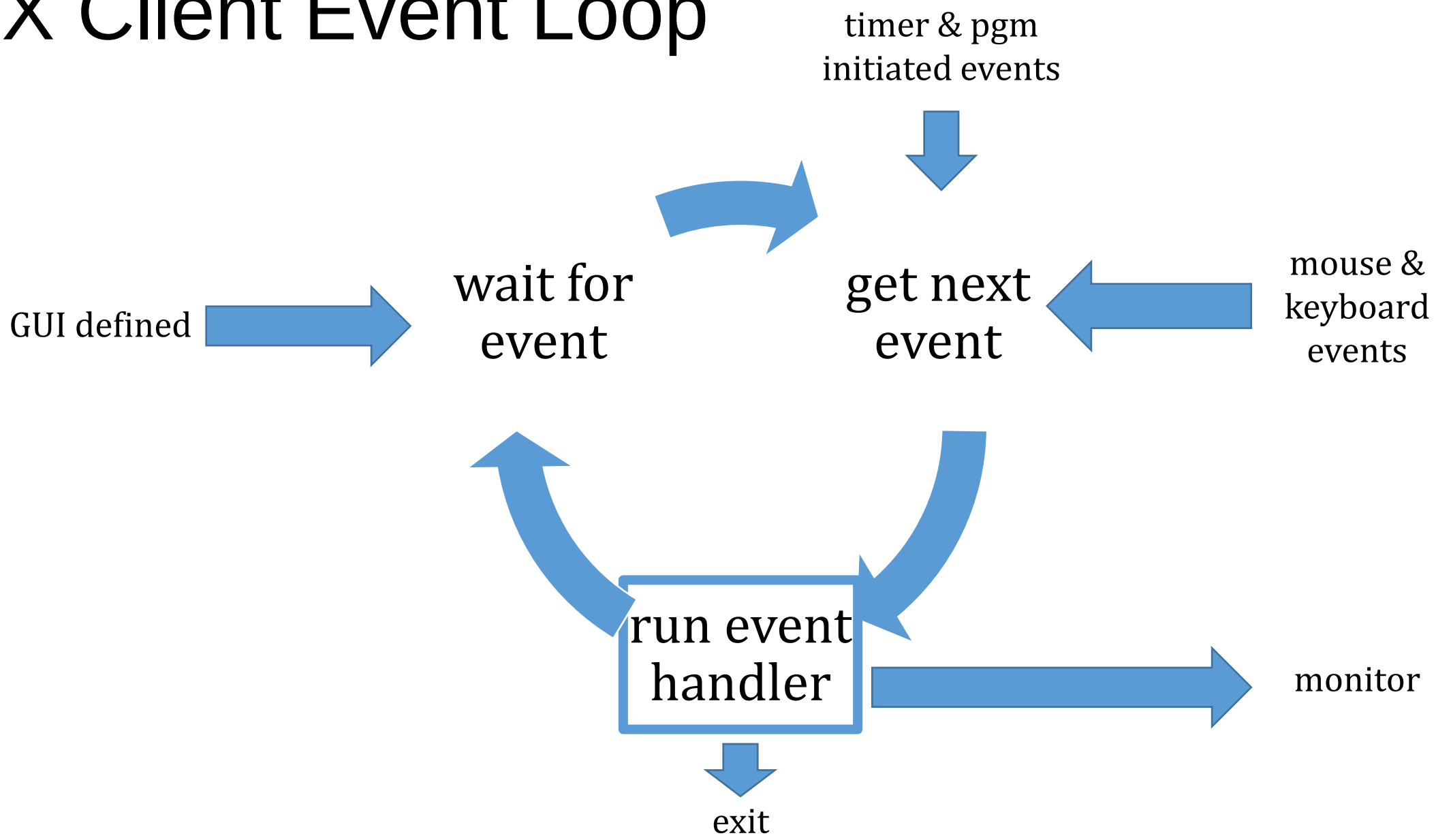


X Server

- Manages all windows for all clients
- Keeps track of an "active" window
  - The one the user is currently interacting with
  - Sends events from active window to appropriate client
- Manages window overlap / movement / minimize, etc.



X Client Event Loop

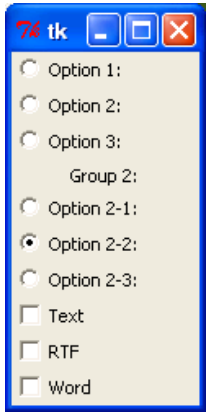


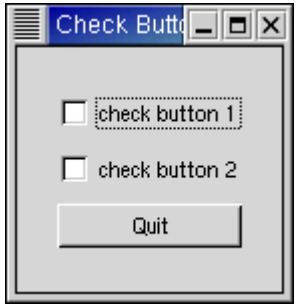
First Class Functions and Callbacks

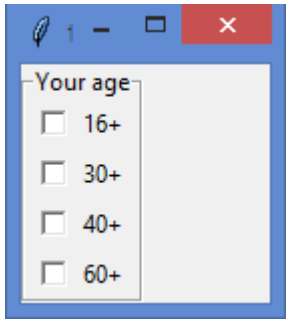
- X client "registers" functions to get invoked when specific events occur
  - "Call me when this button is pushed" (callback)
- Much easier using functions as parameters
  - Lambda functions simplified GUI processing SIGNIFICANTLY!

Java GUI Portability Problem

- Java loves the idea that your code produces the same results on any machine
- The underlying hardware and software of different machines has different GUI capabilities
- Different operating systems implement the same GUI concepts differently







Abstract Window Toolkit (AWT)

- First released in 1995 with Sun's first Java release
- Thin abstract layer between the Java view of a user interface and the underlying hardware/software
- For instance AWT checkbox:
  - maps to Windows checkbox on a Windows machine,
  - maps to X checkbox on Unix machine
- Simple, but not hardware independent
- Based on X11 style of programming (event loop)

Swing

- Built on top of AWT
- Coded in 1997 (Released Java 1.2)
- Name derived from code-name because Sun programmers liked swing music
- Deeper interface… less dependent on machine / operating system
  - More complicated – (18 packages, 737 classes as of JDK 8)

JavaFX

- Built on top of Swing
- Makes the creation of a GUI "simpler"
- Requires a GUI building tool
  - 3rd party tool with different release levels, interactions with Eclipse, etc.
  - Hides the details of the GUI from the coder
  - Swing/Java code generator
- "Removes" capability
  - Simple Swing only, to simplify code generator
  - Override the GUI builder to get that capability back… if you know Swing
- No longer packages with JDK
- Use if you want, but we teach Swing