Clocks, User Interfaces: Keyboard, Mouse, Monitor and Power Management

Group 5

Clocks

Hardware Clock

- **Crystal Oscillator** => Quartz Crystal cut and mounted under tension that can be used to generate a periodic signal

- **Counter** => Decremented each pulse and when it hits zero it causes a cpu interrupt

- **Holding Register** => Used to load the counter

Modes of Operation

- **One-Shot Mode** => Copies value into holding register into counter and then decrements counter at each pulse from crystal.

- **Square-Wave Mode** => After the counter gets to zero and causes an interrupt, holding register is copied into counter and whole thing is repeated. Interrupts are called clock ticks.

- Interrupt Frequency can be controlled by software.

Getting the Time.

- Battery-Powered Backup Clock (same as low power digital watches)

- Clock read at startup, if not present will prompt user for date and time.

- Standard way for system to get time from network.

- Time is then translated into the number of clock ticks since 12 a.m. on Jan 1, 1970 (Universal Coordinated Time) for UNIX or Jan 1, 1980 for Windows

Clock Software

1. Maintain time of day

2. Prevent processes from running outside of allowed time

3. Account for CPU Usage

4. Handle alarm system call made by user processes

5. Providing watchdog timers for parts of the system

6. Profiling, Monitoring, statistics gathering

Maintaining time of day

- Real Time
- Incrementing a counter every clock tick
- At a clock kf 60 HZ a 32-bit counter will overflow in a little over 2 years
- Solutions:
    - Use 64 bit counter
    - Maintain time of day in seconds, use secondary counter to count ticks until whole second, will work until 22nd century (2^{32} seconds more than 136 years)
    - Count in ticks relative to the time the system is booted, stored time is added to counter when requested

Preventing processes from running outside of allowed time

- Process started scheduler starts a counter to value of the process' quantum in clock ticks

- At every interrupt the counter is decremented by one

- When the counter gets to zero the scheduler is called to set up another process

Accounting for CPU usage - Accurate

- Start a secondary timer whenever a process is started

- When the process stops the timer can be used to tell how long the process has run

- The timer should be saved whenever there is an interrupt and restored after

- Too expensive and rarely done

Accounting for CPU usage - Inaccurate

- Maintain a pointer to process table entry for the currently running process

- At each clock tick a field in the current process entry is incremented

- Each clock tick is charged or attributed to the process running when the tick occurs

- If a lot of interrupts occur while the process is running it is still charged or attributed a full tick even though it didn't get much done (inaccurate)

Handling the alarm system call made by user processes.

- Process can request that OS gives it warning after a certain amount of time has passed

- Warning can be: signal, interrupt, message, etc.

- Example:
  - Networking - Packet not acknowledged within a time limit must be retransmitted

Watchdog Timers

- Set to cause an interrupt after a sufficiently long time interval
  - Example: A floppy disk does not rotate when it is not in use (to avoid wear and tear) so a watchdog timer is set when the disk is accessed, so that the motor will stop spinning after a certain amount of time

- Mechanism the same as user signals

- Calls a procedure supplied by the caller

- Only works when clock driver and procedure to be called are in same address space

Profiling, Monitoring, & Statistics

- Program can have the system build a histogram of its program counter

- Where is time being spent?

- Method:
  - Every tick the clock drivers checks to see if the process is being profiled
  - Computes the range of addresses (bin number) that corresponds to current program counter
  - Increments the bin by 1

Soft Timers

- Interrupts have high overhead and polling has high latency

- Whenever the kernel is running for any reason the real time clock is checked to see if a soft timer expired. If it has, the scheduled event is performed, and the timer is reset.

- Scheduled events may be late due to how often the kernel is being accessed, but this is better than the high cpu usage that interrupts cause

UNIX Time

- https://www.youtube.com/watch?v=QJQ691PTKsA

Keyboard

Communication with the system

- The keyboard uses an embedded microprocessor to relay information to the parent board

- 'Keyboard Interrupts' and occur when a key is pressed then again when it is released

- At each interrupt the keyboard driver grabs the info about what happens from the I/O port

- Everything else happens in software

Keyboard Software- scan code

- The scan code is the key number in the I/O port (this is not ascii code).

- Keyboards have fewer than 128 keys. This way only 7 bits are needed to designate the key and the 8th can show the interrupt

- After an I/O register receives the scan code, interpreting this code is left to the driver.

Keyboard Software -interface,buffer

- Although this keyboard interface puts the full burden on the software, it is extremely flexible.
  - Example: user programs may be interested in whether a digit just typed came from the top row of keys or the numeric keypad on the side

- Buffering can be used on keyboards to hold character until the command line or any other input is ready to except the character coming through.

- Buffering gives the shell time to get ready for the characters inputs.

Keyboard Software - Echoing , tab

- Although the keyboard and monitor are logically separate devices, many users have grown accustomed to seeing the characters they have just typed appear on the screen. This process is called echoing.

- Echoing has to write to the screen while user is typing and the keyboard drivers need to figure out where to put the new inputs.

- Tab handling has to keep up with the cursor and know the proper number of spaces and outputs of echoes.

Keyboard Software -multiuser

- On multiuser systems such as mainframes, its up to the keyboard driver to make sure that all inputs go to the right frame work

- The POSIX standard uses the less-picturesque term 'Canonical Mode' to describe line-oriented mode

- When operating in Canonical Mode, some input characters have special meanings.

Keyboard Software-special characters

Character	POSIX name	Comment
CTRL-H	ERASE	Backspace one character
CTRL-U	KILL	Erase entire line being typed
CTRL-V	LNEXT	Interpret next character literally
CTRL-S	STOP	Stop output
CTRL-Q	START	Start output
DEL	INTR	Interrupt process (SIGINT)
CTRL-\	QUIT	Force core dump (SIGQUIT)
CTRL-D	EOF	End of file
CTRL-M	CR	Carriage return (unchangeable)
CTRL-J	NL	Linefeed (unchangeable)

This table shows all of the special characters required by POSIX

Mouse
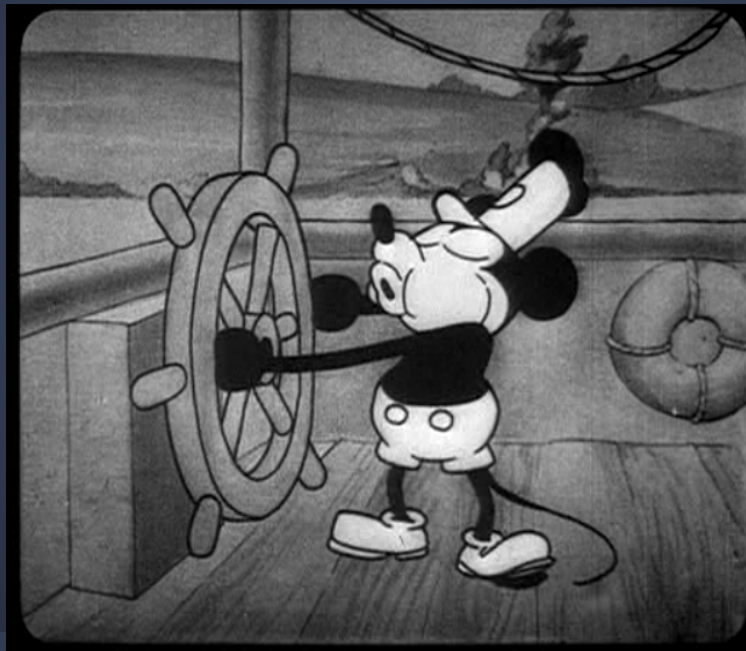
Trackball

- This type of mouse has a rubber ball resting in a hole at the bottom

- The rubber ball moves as a mouse is moved over a surface

- Rubber Rollers that rotate
  - left-right causes shaft parallel to the y axis rotate
  - up-down causes shaft parallel to the x axis to rotate

Optical Mouse

- Equipped with one or more light emitting diodes and photodetectors on bottom

- Used to have to use them on a special mousepad with a grid so the mouse could count the lines crossed and detect where it was

- Now mice have an image processing chip that take low-res photos of what's underneath them and use the differences between pictures to detect movement

Mouse Communication

- Minimum distance for movement is usually called 0.1 mm (This unit is called a Mickey.)

- Message contains Delta X, Delta Y, and Buttons

- Usually it takes 3 bytes depending on the amount of buttons

- Mice usually report back a max of 40 times per second

- Mouse only calculates changes in position, not absolute position

- Double clicks are usually determined by if the clicks are close enough in space and time (usually user configurable)

Monitor

Text windows and graphical user interfaces

Text Windows

- Output is sequentially in a single font, size, and color

- Program sends characters to the current window and they are displayed there

- Usually, a block of characters, for example, a line, is written in one system call

Escape Sequences

- Screen editors and other programs need to update the screen in complex ways such as replacing one line in the middle of the screen

- To accommodate this need, most output drivers support a series of commands often called escape sequences

- In Berkeley, UNIX a terminal database called termcap was introduced to define a number of basic actions

Examples

| Escape Sequence	Meaning
ESC [nA	Move up n lines
ESC [nB	Move down n lines
ESC [nC	Move right n spaces
ESC [nD	Move left n spaces
ESC [m; nH	Move cursor to (m,n)
ESC [sJ	Clear screen from cursor (0 to end, 1 from start, 2 all)
ESC [sK	Clear line from cursor (0 to end, 1 from start, 2 all)
ESC [nL	Insert n lines at cursor
ESC [nM	Delete n lines at cursor
ESC [nP	Delete n chars at cursor
ESC [n@	Insert n chars at cursor
ESC [nm	Enable rendition n {O=normal, 4=bold, 5=blinking, 7=reverse)
ESC [M	Scroll the screen backward if the cursor is on the top line

The X Window System (X)

- Developed at MIT as part of project Athena in the 1980s

- Very portable and runs entirely in user space

- Originally intended for connecting many remote user terminals with a central computer server

- Split into client software and host software, which can potentially run on different computers

- On modern personal computers, both parts can run on the same machine

Xlib

- X is just a windowing system and to get a complete GUI, other layers of software need to run on top of it.

- One layer is Xlib, which is a set of library procedures for accessing the X functionality

- These procedures form the basis of X and are too primitive for most user programs to access directly

Layers
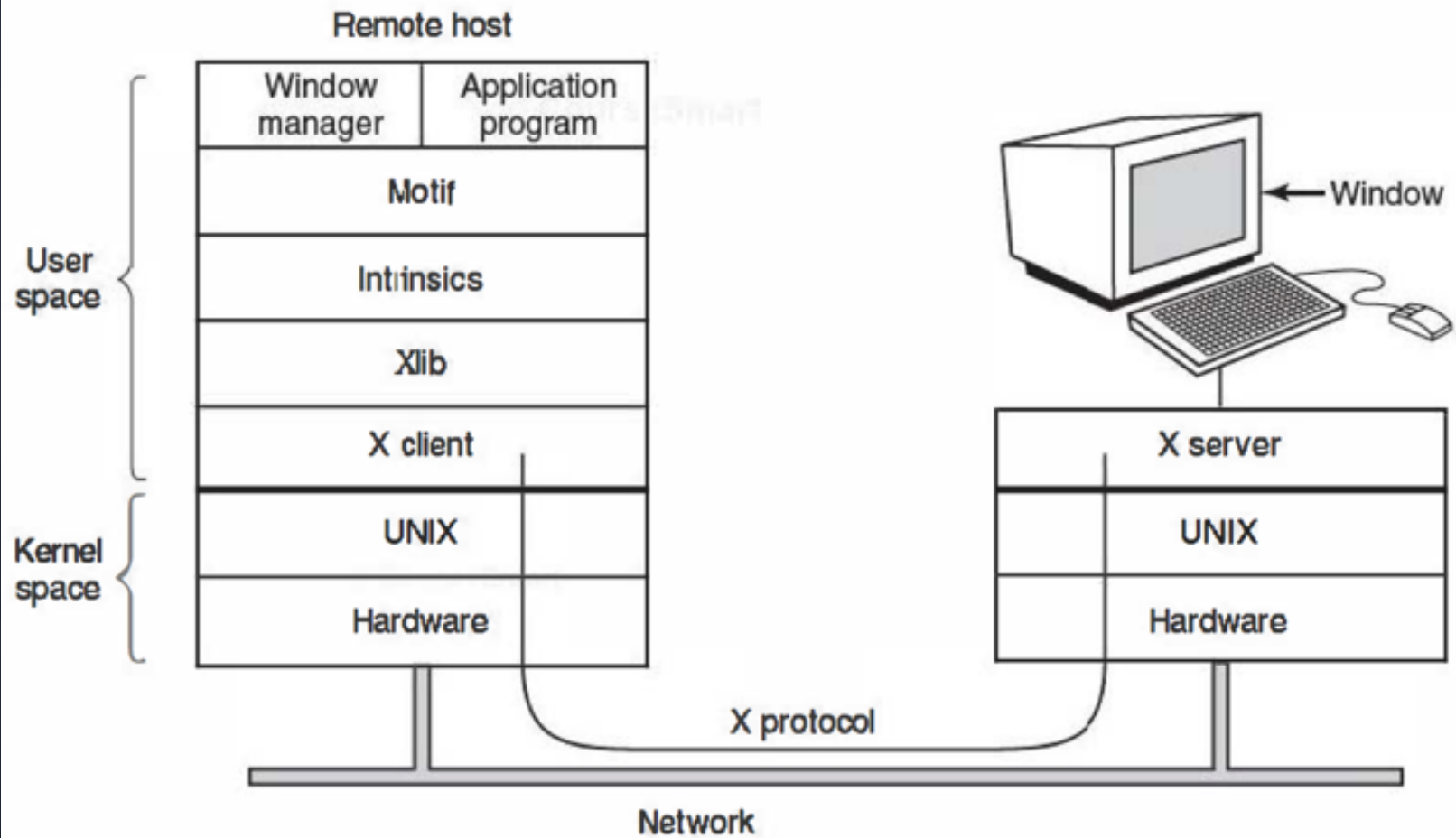
X's Window Management

- Window management is not part of X itself

- A separate X client process, called a window manager, controls the creation, deletion, and movement of windows on the screen

- To manage windows, it sends commands to the X server telling what to do

- It often runs on the same machine as the X client, but in theory can run anywhere

TCP/IP Connections in X

Four kinds of messages go over the connection:

1. Drawing commands from the program to the workstation.

2. Replies by the workstation to program queries.

3. Keyboard, mouse, and other event announcements.

4. Error messages.

Graphical User Interface (GUI)

- Invented by Douglas Engelhart and his research group at the Stanford Research Institute

- Copied by researchers at Xerox PARC

- Steve Jobs got the idea for a new computer (Apple Lisa) from a GUI on a Xerox computer

- The Lisa was too expensive but its successor, the Macintosh, was a commercial success

GUI elements

- *Windows* - blocks of screen areas used to run programs

- *Icons* - little symbols that can be clicked on to cause some action to happen

- *Menus* - lists of actions from which one can be chosen

- *Pointing device* - a mouse or other hardware device used to move a cursor around the screen to select items
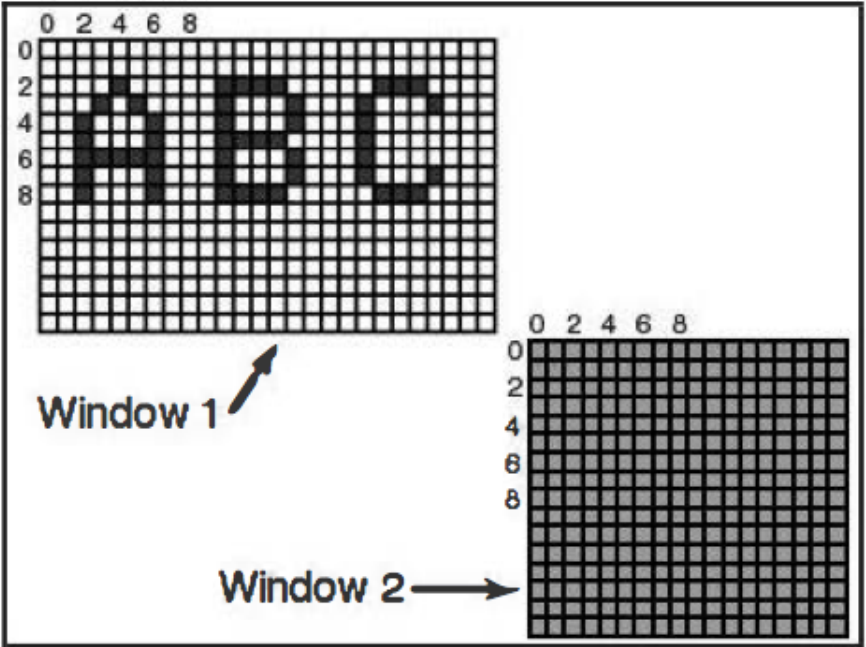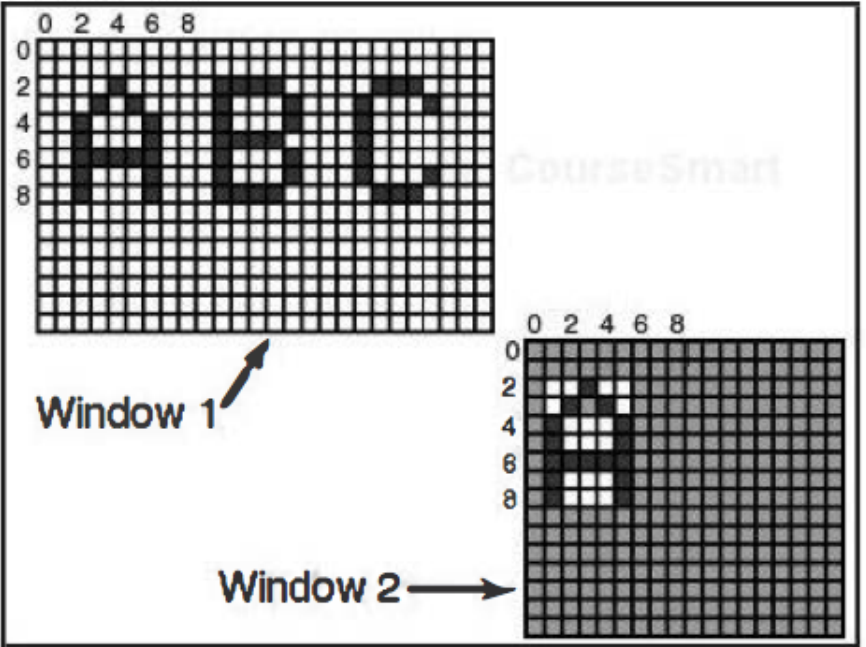
Windows
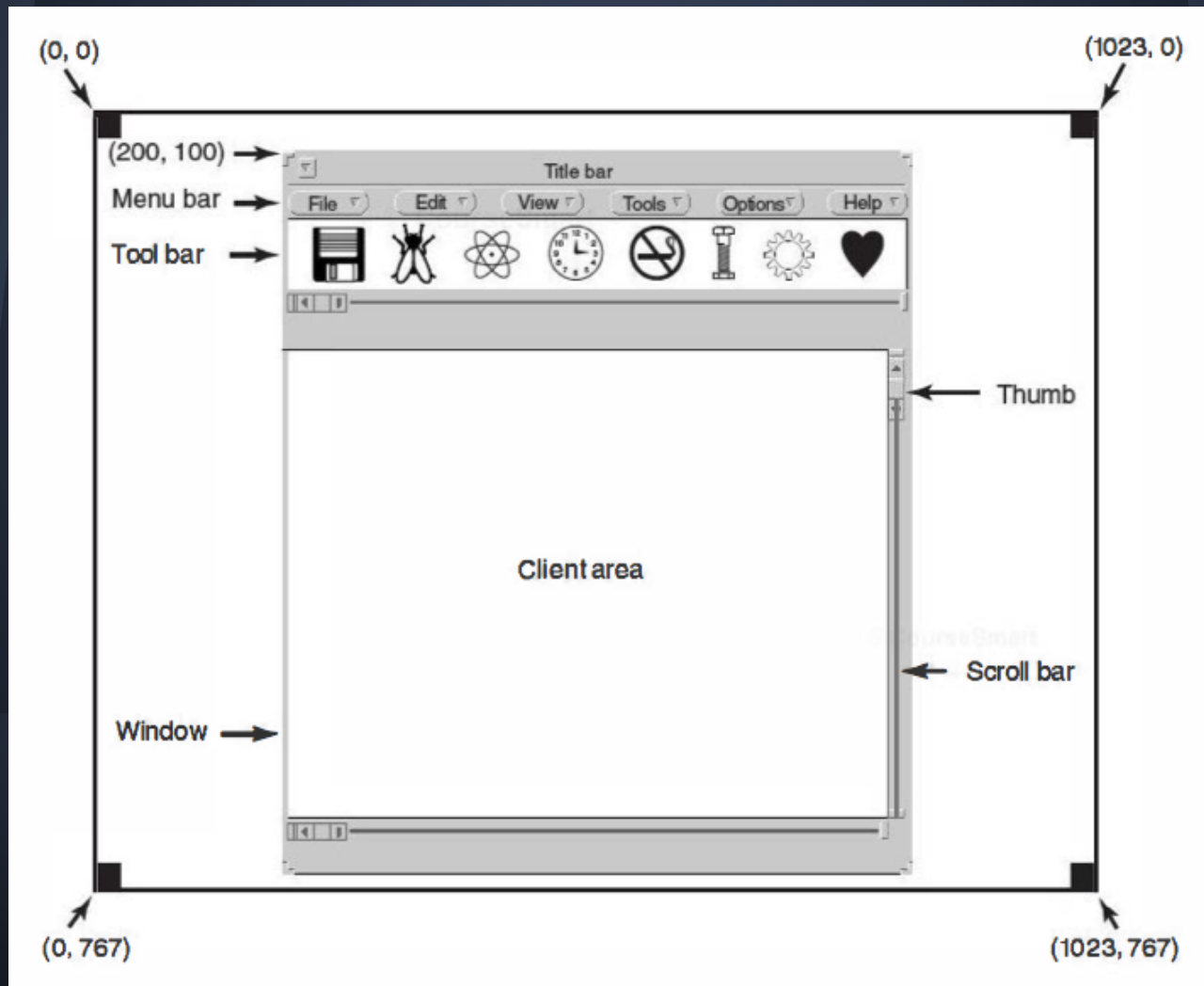
Bitmaps

- Not all the images that computers manipulate can be generated using vector graphics.

- Photographs and videos, for example, do not use vector graphics. Instead, these items are scanned in by overlaying a grid on the image.

- The average red, green, and blue values of each grid square are then sampled and saved as the value of one pixel.

- This file is called a bitmap.

Bitblt

(a)   (b)

Fonts

- In versions of Windows before 3.1, characters were represented as bitmaps and copied onto the screen or printer using BitBlt.

- The problem is that a bitmap that makes sense on the screen is too small for the printer.

- Also, a different bitmap is needed for each character in each size.

TrueType fonts

- Are not bitmaps but outlines of the characters

- Each TrueType character is defined by a sequence of points around its perimeter

- All the points are relative to the (0, 0) origin. Using this system, it is easy to scale the characters up or down

- All that has to be done is to multiply each coordinate by the same scale factor

- This way, a True-Type character can be scaled up or down to any point size
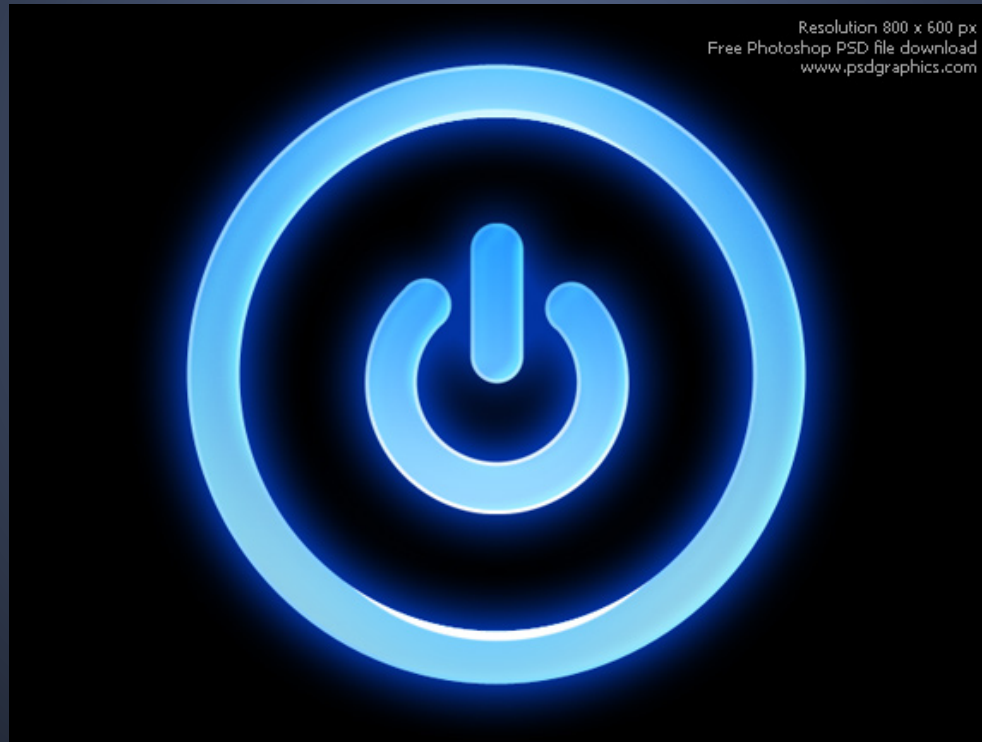
Character Outlines

20 pt: abcdefgh

53 pt: abcdefgh

81 pt: abcdefgh

Power Management

Resolution 800 x 600 px
Free Photoshop PSD file download
www.psdgraphics.com

The purpose power management

- The ENIAC,had 18000 vacuum tubes and consumed 140000 watts.

- Transistor was soon invented and power usage was dropped dramatically, then the computer industry lost interest in power management.

- If 100 million desktop computers where turn on at the same time worldwide and together it will use 20,000 megawatts.

- Portable computer is another issue that are battery powered and can't hold a charge as long as a few hours

- Two general approaches to reduce energy consumption: operation system and application programs.

Three types of issues that deal with power management

- Hardware Issues

- Operating System issues

- Application Program issues

Device	Li et al. (1994)	Lorch and Smith (1998)
Display	68%	39%
CPU	12%	18%
Hard disk	20%	12%
Modem		6%
Sound		2%
Memory	0.5%	1%
Other		22%

Figure 5-45. Power consumption of various parts of a notebook computer.

Hardware Issues

- **Batteries** - two types: disposable and rechargeable
  - disposable - does not contain enough energy maintain powerful notebook
  - rechargeable - can last for few hours on a notebook

- The battery was made of nickel cadmium but is now switched to Lithium ion

- Creating multiple states that the cpu,memory, and I/O devices could use to control and save energy being use in the battery

- These multiple states are: ON, SLEEP, HIBERNATE, and OFF

- Not all Computer systems have theses states but it is operating system job to make sure it transition into theses states.

- Energy consumption would be from ON (Greater)...... to OFF (least)

Operating System Issues

- The Operating system plays a key role in energy management.

- It controls all the devices, so it must decide what to shut down and when to shut it down.

- If it shuts down a device and that device is needed again quickly, there may be an annoying delay while it is restarted. On the other hand, if it waits too long to shut down a device, energy is wasted for nothing.

Operating System Issues

Main issue

- The Display
- The Hard Disk
- The CPU
- The Memory
- Wireless Communication
- Thermal Management
- Battery Management
- Driver Interface

Application Program Issues

- Programs can help degrade the performance depending on the how much power the battery has and if the battery is low it could possible tell the use it can't use the program.

- powerscope measure the energy usages in the programs. it was used for 4 different programs and determines forms of degradation.

- The first program measured was a video player. In undegraded mode, it plays 30 frames/sec in full resolution and in color. A form of some degradation is to turn color in to black and white, another one is to take the quality down, and the last is to turn the pixel count down. this would save energy about 30%.

- The second program was a speech recognizer. It sampled the microphone to construct a waveform. This waveform could either be analyzed on the notebook computer or sent over a radio link for analysis on a fixed computer. Doing this saves CPU energy but uses energy for the radio. Degradation was accomplished by using a smaller vocabulary and a simpler acoustic model. The win here was about 35%.

Application Program Issues

- The next example was a map viewer that fetched the map over the radio link.Degradation consisted of either cropping the map to smaller dimensions or telling the remote server to omit smaller roads, thus requiring fewer bits to be transmitted.Again here a gain of about 35% was achieved.

- The fourth experiment was with transmission of JPEG images to a Web browser. The JPEG standard allows various algorithms, trading image quality against file size. Here the gain averaged only 9%. Still, all in all, the experiments showed that by accepting some quality degradation, the user can run longer on a given battery.