Operating Systems Design
24. Windowing

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User Interfaces: 1st Generation

Historically, the command-line interface

– Still great for scripting, systems management, remote access, and customized operations

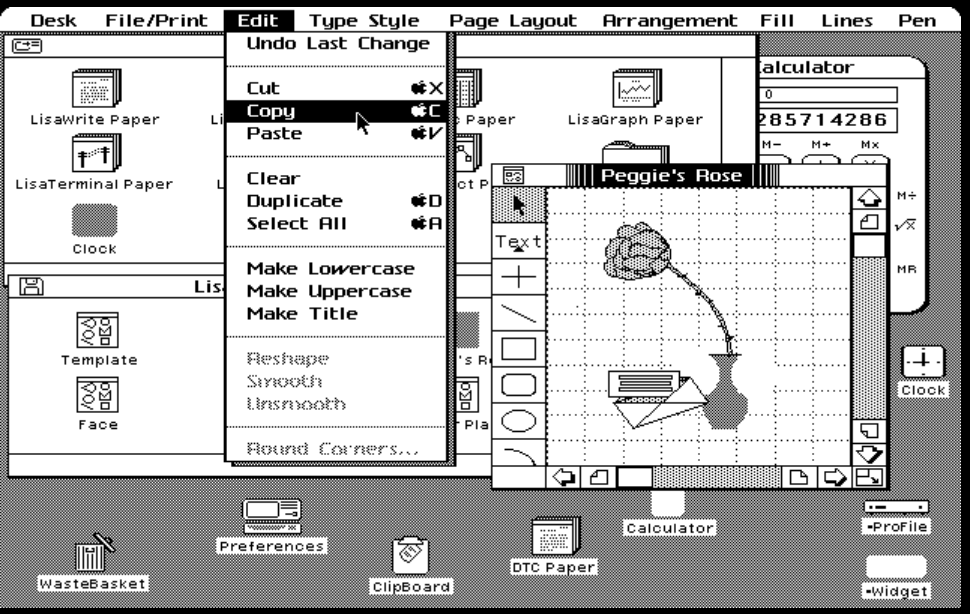
```
cat *.txt | tr -cs "[:alpha:]" "\n" |
    tr A-Z a-z | sed '/^$/d' |
    sort | uniq -c| sort -nr
```

User Interfaces: 2nd Generation

Most users prefer a graphical UI

- Dominant interface:
  - desktop metaphor
  - WIMP (Window, Icon, Menu, Pointer) design paradigm
  - 1964-1968: Douglas Englebart
    - 1968 demo: mouse, windows, hypermedia links, video teleconferencing
  - 1973: Xerox Alto – PC with GUI, folders, mouse, keyboard

WIMP


Desk
File/Print
Edit
Type Style
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Arrangement
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Undo Last Change
Cut
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Select All
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Make Title
Reshape
Smooth
Unsmooth
Round Corners...
LisaWrite Paper
LisaTerminal Paper
Clock
Template
Face
LisaGraph Paper
Peggie's Rose
Text
Calculator
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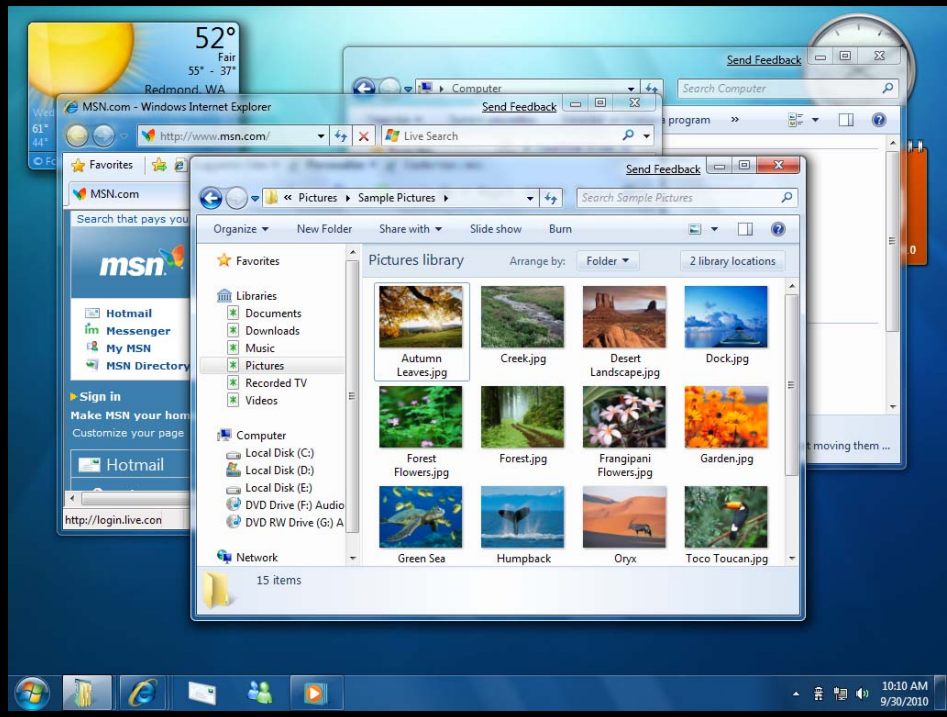
WasteBasket
Preferences
ClipBoard
DTC Paper
ProFile
Widget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Fair
Redmond, WA
MSN.com - Windows Internet Explorer
Send Feedback
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Search Sample Pictures
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Burn
Pictures library
Arrange by:
Folder
2 library locations
Favorites
Libraries
Documents
Downloads
Music
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Recorded TV
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Computer
Local Disk (C:)
Local Disk (D:)
Local Disk (E:)
DVD Drive (F:) Audio
DVD RW Drive (G:) A
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Autumn Leaves.jpg
Creek.jpg
Desert Landscape.jpg
Dock.jpg
Forest Flowers.jpg
Forest.jpg
Frangipani Flowers.jpg
Garden.jpg
Green Sea
Humpback
Oryx
Toco Toucan.jpg
15 items
msn
Hotmail
Messenger
My MSN
MSN Directory
Sign in
Customize your page
10:10 AM
9/30/2010

User Interfaces: 3rd Generation

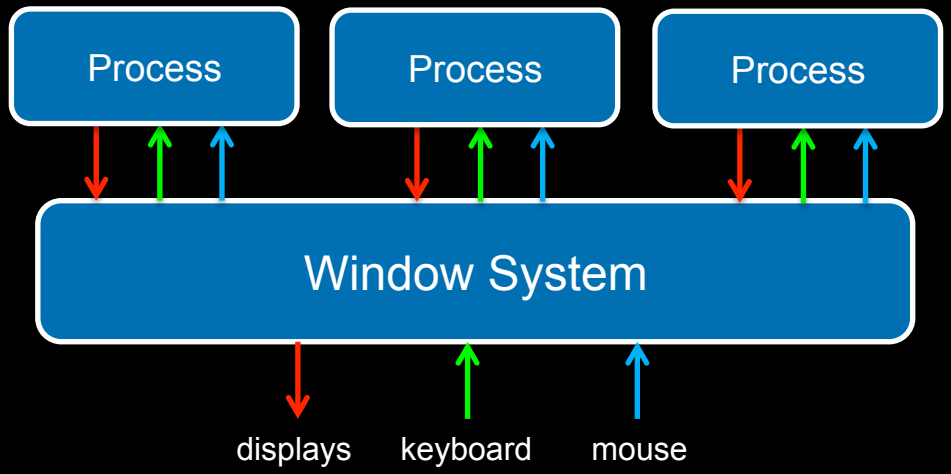
- Touch (& multitouch) interactive
  - No windows, mouse, pointer
  - Jeff Han, NYU: Multitouch sensing, 2006
  - Huge mindshare due to the popularity of the iPhone & iPad

Hardware for graphics

- Fundamental interface
  - Framebuffer
    - Memory buffer containing a video frame
    - Memory mapped into system's memory space
- Graphics accelerator (GPU)
  - Send drawing commands to the GPU, which rasterizes the results onto a framebuffer
  - Abstraction libraries: *OpenGL, DirectX/Direct3D*
    - Provide a uniform interface for hardware graphics
    - Translate commands into GPU-specific commands
      - GPUs are multithreaded; driver may control thread scheduling
    - GPU's results are sent sent to the framebuffer

Windowing System

- Interfaces with mice, keyboards, cursor, & graphics HW
- Provides virtual interfaces to processes
  - Virtual screen (framebuffer)
  - Virtual keyboard
  - Virtual mouse



Window Manager

- Handles interactions between windows, applications, and the underlying windowing system
- Does not interact with the hardware
- Stacking (floating) window manager
  - Draws windows in a specific order (sorted by z-order)
  - Allow overlapping windows by drawing background windows first
  - Contents have to be redrawn when window new parts exposed
  - Limited ability to accelerate with a graphics card
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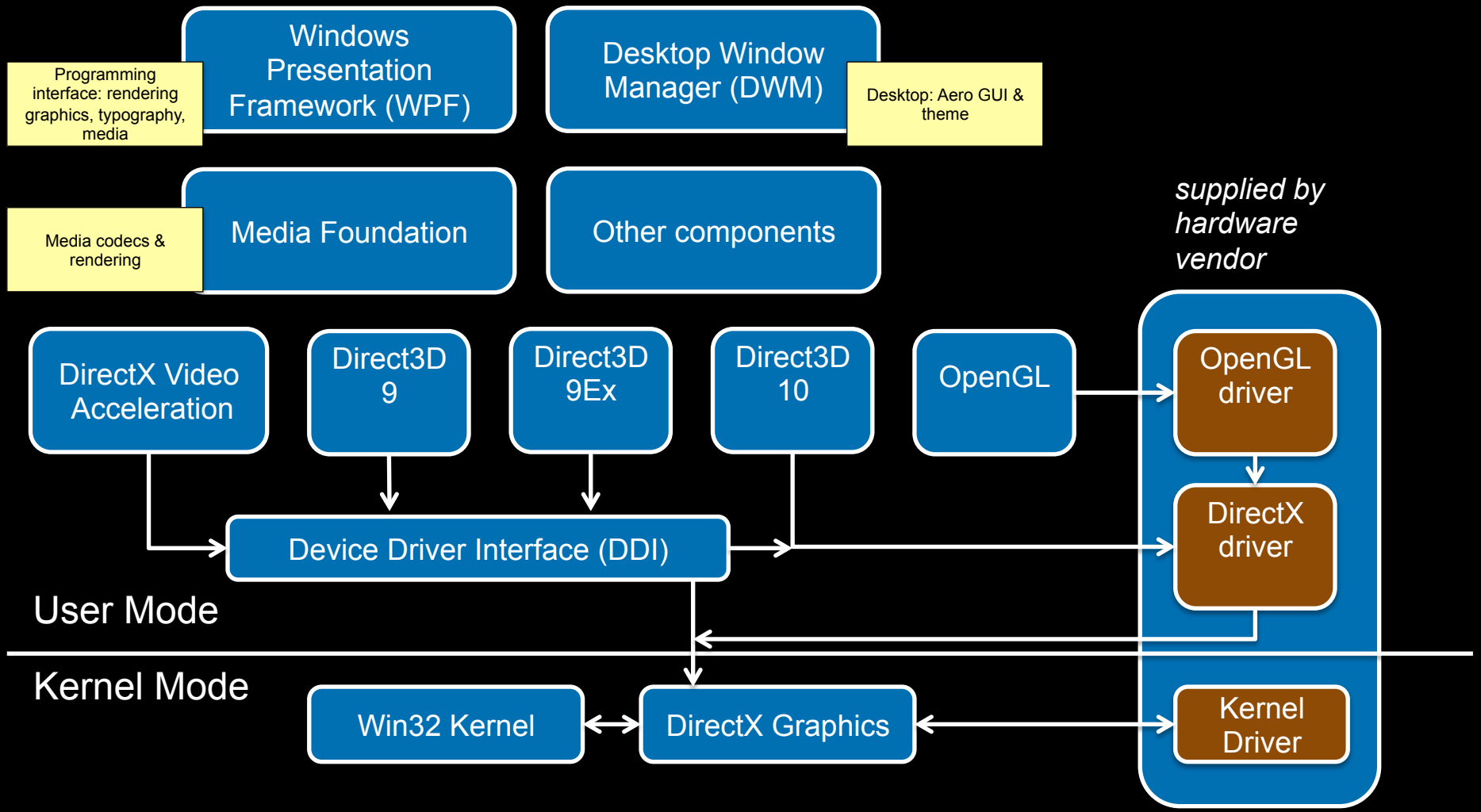
  - Used in X Windows & Windows XP
- Compositing window manager
  - Windows drawn separately. Graphics HW places them in a 2D or 3D environment
  - OS X, Vista and Windows 7 use this
- Hybrid: treat foreground window differently: have graphics card render it

Kernel Interface: Windows ≥ Vista

Windows Display Driver Model (WDDM)

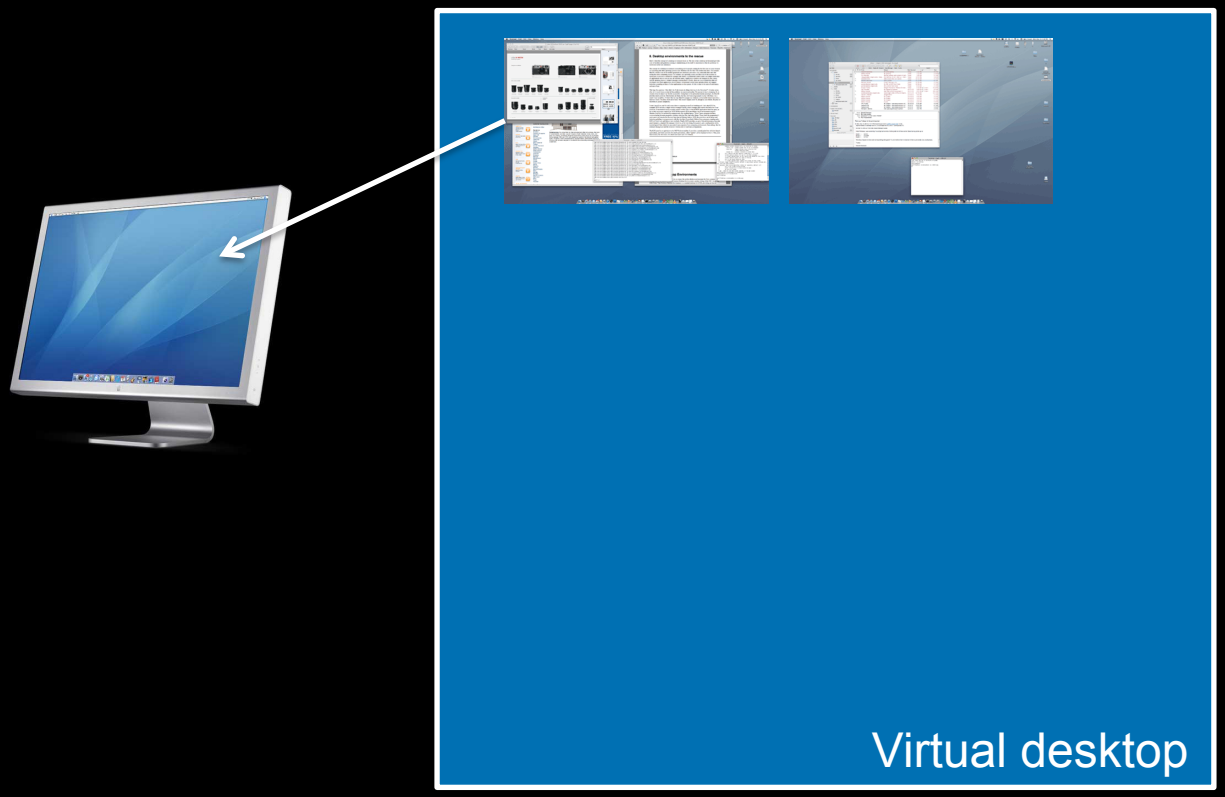


Windows Display Driver Model

- Virtual video memory (memory protection)
- GPU thread scheduling
- Lots of rendering APIs
  - Legacy: DirectDraw, Direct3D (3..8)
  - Mainline: GDI, Direct3D 9/9Ex, OpenGL
  - New: Direct3D 10, Windows Presentation Foundation
- Separate rendering from device management
  - Direct3D 10 manages graphics
  - DXGI component manages
    - Adapters, display modes, output, gamma/color, monitor controls
- Desktop Window Manager
  - Composited desktop

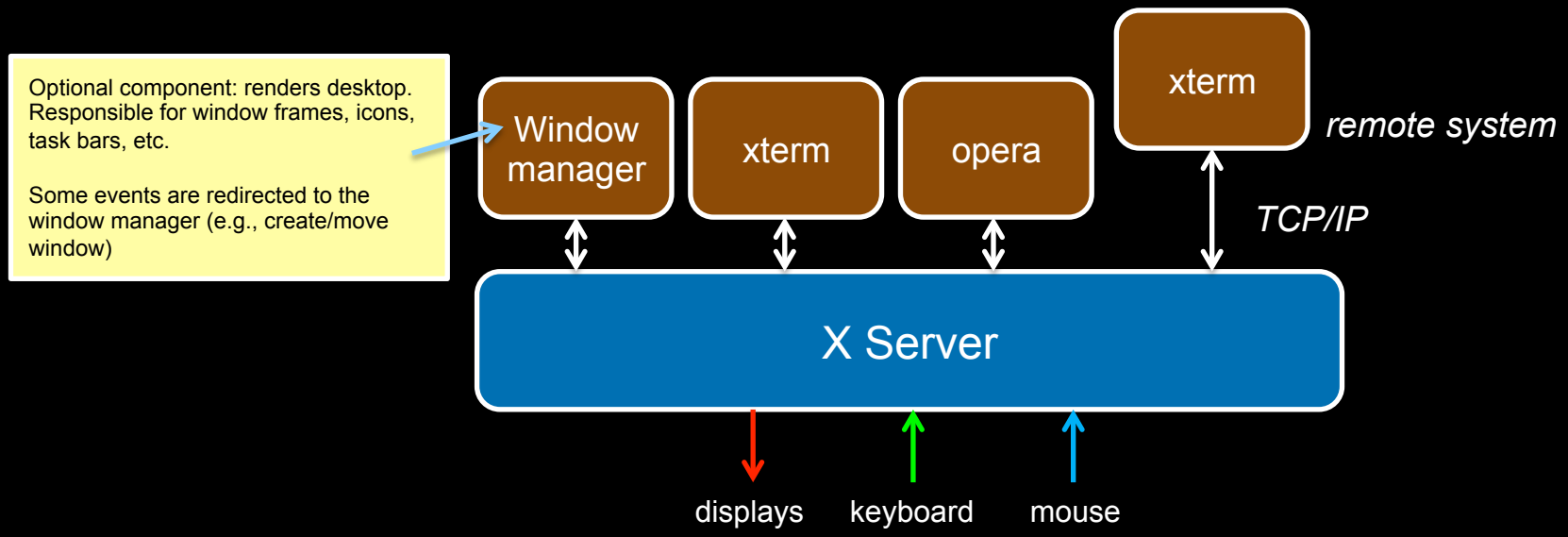
Virtual desktop

- Large virtual desktop (64K × 64K)
- Portions are mapped to monitors through views



X Window System (X11)

- Window system
  - User-level interface to hardware
  - Manages graphics card, keyboard, and mouse
  - I/O multiplexing
  - Client-server API
    - Create/destroy windows
    - Basic drawing (text, lines, fills) commands into windows



X Windows

- X Server
  - Provides *mechanism*, not *policy*
  - Provide windows, drawing primitives, cut buffers, text rendering
- Window manager
  - Application that runs on X
  - Controls the placement & appearance of windows, icons, …
  - fvwm, 3dwm, afterstep, Window Maker, Enlightenment, …
- Widget Libraries (Toolkits, APIs)
  - Common UI components: scrollbars, sliders, dialog boxes, …
  - Gtk, At, LessTif
- Desktop environments
  - Window manager + applications to provide consistent UI (program launchers, …)
  - GNOME, KDE Software Compilation, CDE, …

The End