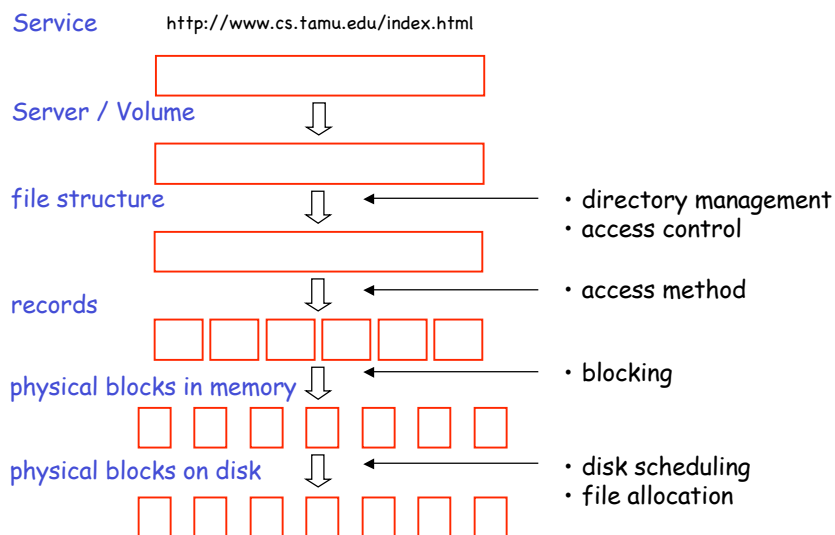


Introduction to I/O

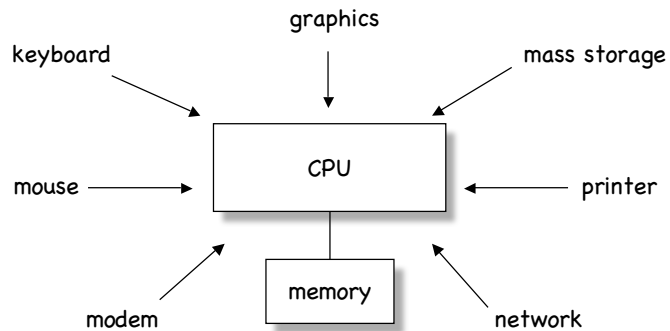
- 1-Slide Overview to File Management
- I/O Hardware
- I/O Application Interface
- I/O Subsystem Issues

Note: much material in this set of slides comes directly from Solomon&Rusinovich, "Inside Windows 2000," Microsoft Programming Series.

Short Interlude: The Logical View of File Management



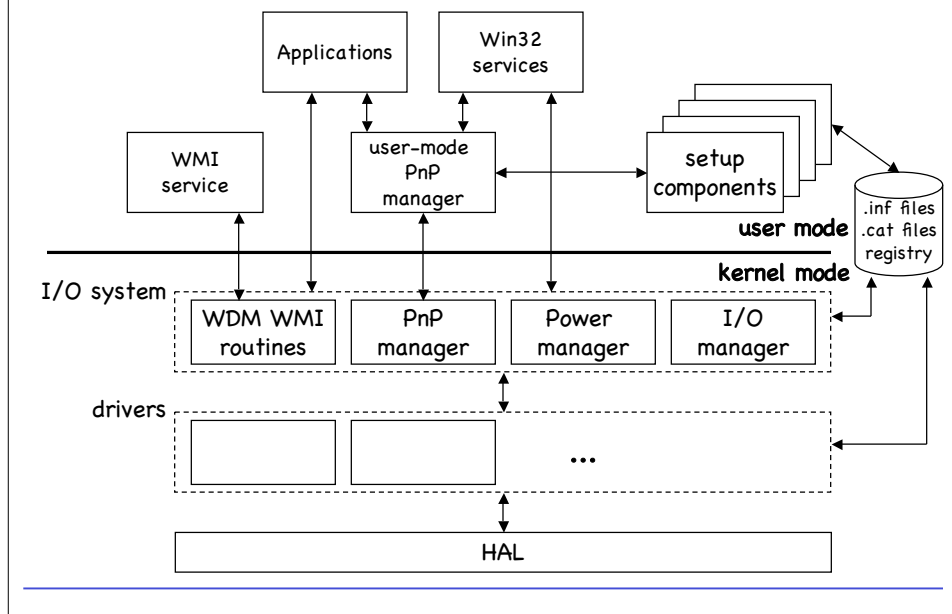
I/O Devices



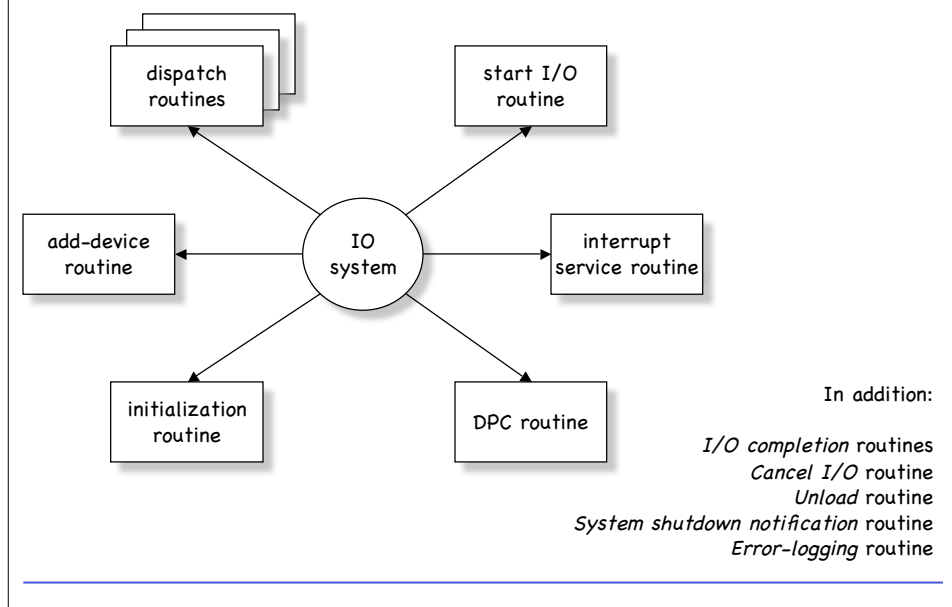
Where is the Control of I/O Functions?

- Processor directly controls device.
- Controller or I/O module is added. Processor uses programmed I/O without interrupts.
- Same, but with interrupts.
- The I/O module is given direct control of memory via DMA.
- I/O module is separate processor, with special instruction set and access to memory to execute I/O program. No CPU intervention.
- I/O module has local memory of its own. Can control several I/O devices.
- Intelligent I/O (I₂O).
- Data-near computation: portions of applications are migrated to I/O controllers.
- TCP offload: Run protocols on network interface card.
- TAMU-PANIC (Protocols Aboard Network Interface Cards) project: portions of application run in network interface cards.

IO System Components (Windows 2k)



W2k Primary Device Driver Routines



W2k I/O Data Structures

- **File Objects:** Handles to files or devices.

 - **Driver Objects:** Represent individual driver in the system. I/O Manager has references to Dispatch Routines.

 - **Device Objects:** Represent physical or logical devices in the system. Contain all information about device characteristics, buffer locations, etc.
-

W2k File Objects

Filename	Identifies the physical file that the file object refers to
Current byte offset	Identifies the current location of the file (valid only for synchronous I/O)
Share modes	Indicate whether other callers can access the file while the current caller is using it.
Open mode flags	Indicate whether I/O will be synchronous or asynchronous, cached or non-cached, sequential or random, etc.
Pointer to device object	
Pointer to volume parameter block	Indicates the volume, or partition, that the file resides on.
Pointer to section object pointers	Indicates a root structure that describes a mapped file.
Pointer to private cache map	Identifies which part of the file are cached by the cache manager

Opening a File Object (W2k)

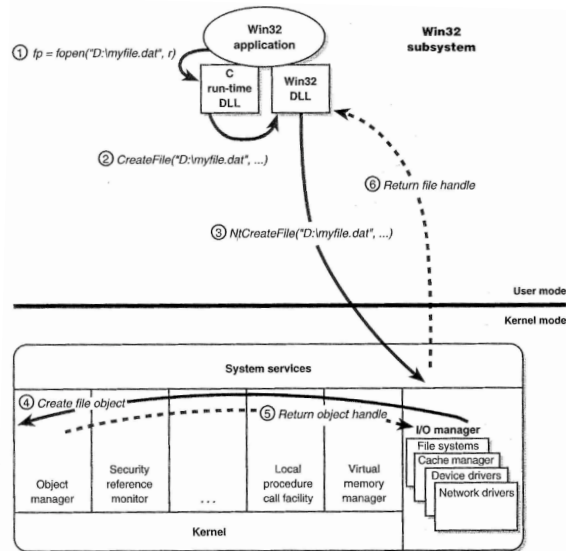


Figure from Solomon&Russinovich, "Inside Windows 2000," Microsoft Programming Series

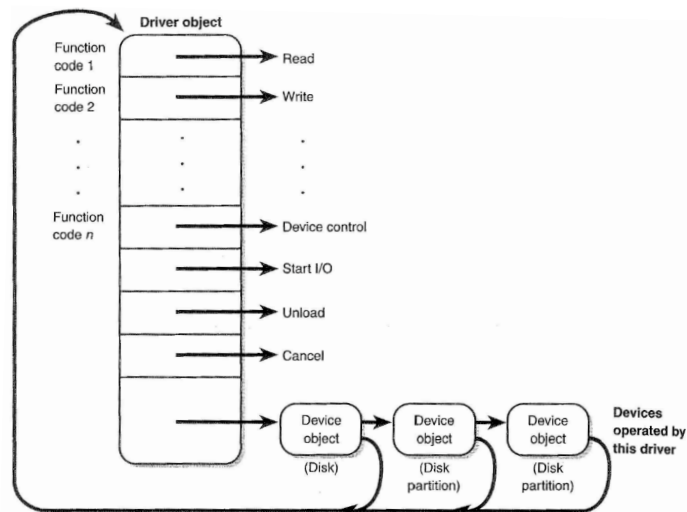


Figure from Solomon&Russinovich, "Inside Windows 2000," Microsoft Programming Series

W2k I/O Data Structures (simple I/O request)

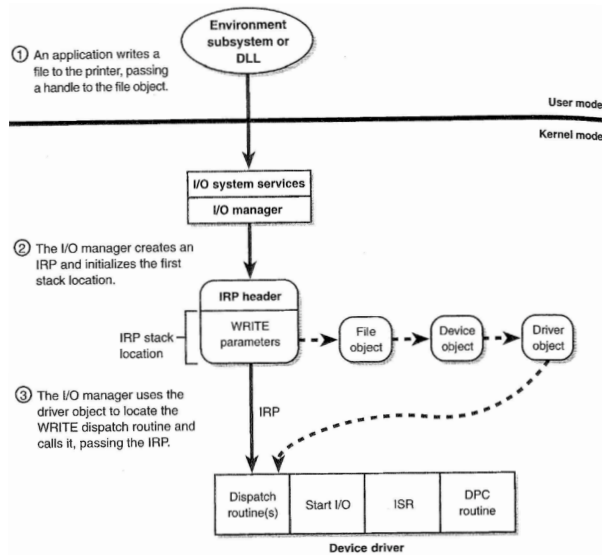
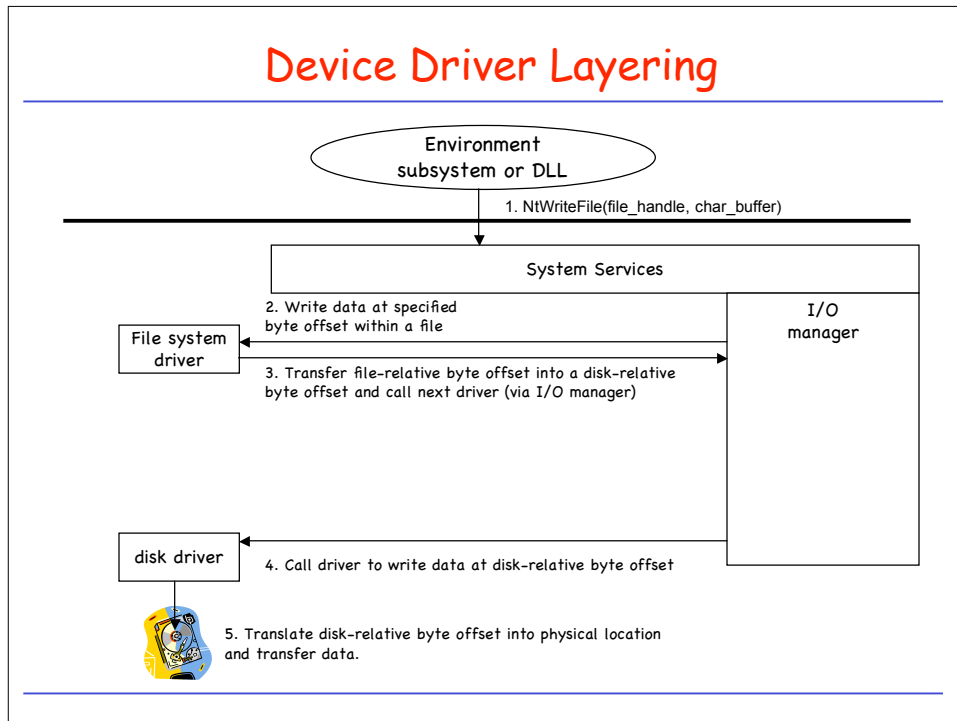


Figure from Solomon&Russinovich, "Inside Windows 2000," Microsoft Programming Series

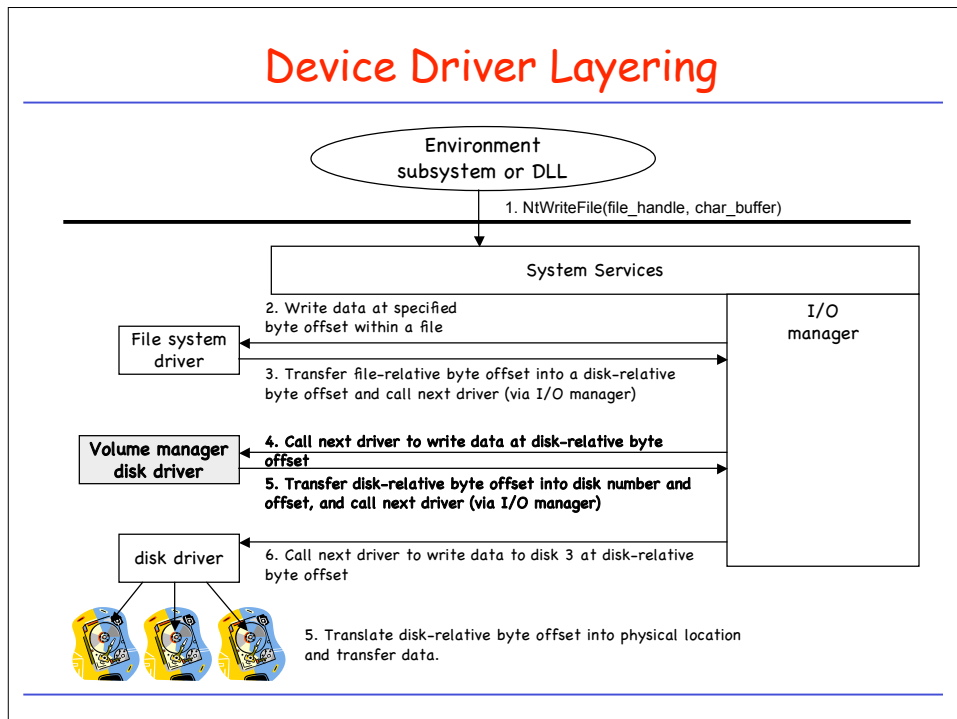
Windows Driver Model (WDM) Drivers

- **Bus Drivers** manage logical or physical bus (PCMCIA, PCI, USB, IEEE 1394, ISA). Interfaces to
 - PnP Manager -- to detect and inform about devices attached to bus.
 - Power Manager -- to control power settings of devices on bus.
- **Function Drivers** manage particular type of device. Exports operational interface of device.
- **Filter Drivers** logically layer above or below function drivers.
 - Augment or modify behavior of device or another driver.

Device Driver Layering



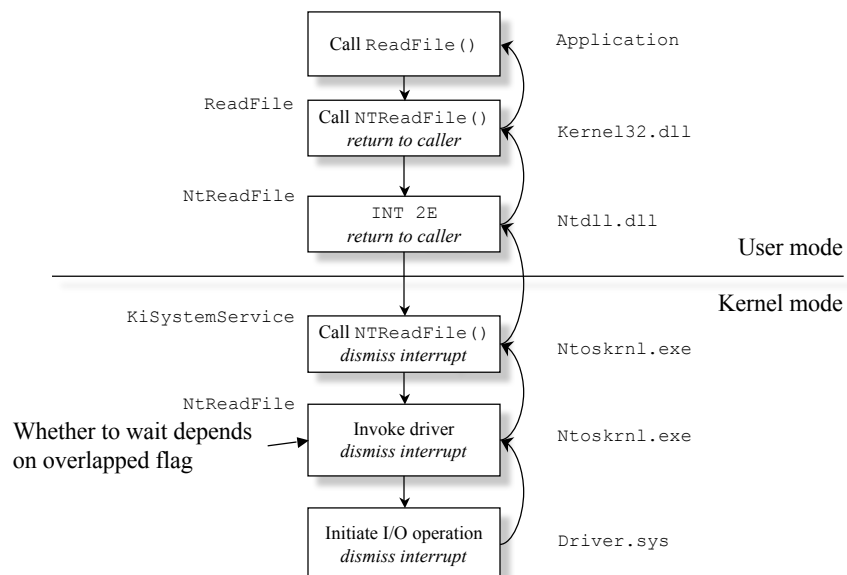
Device Driver Layering



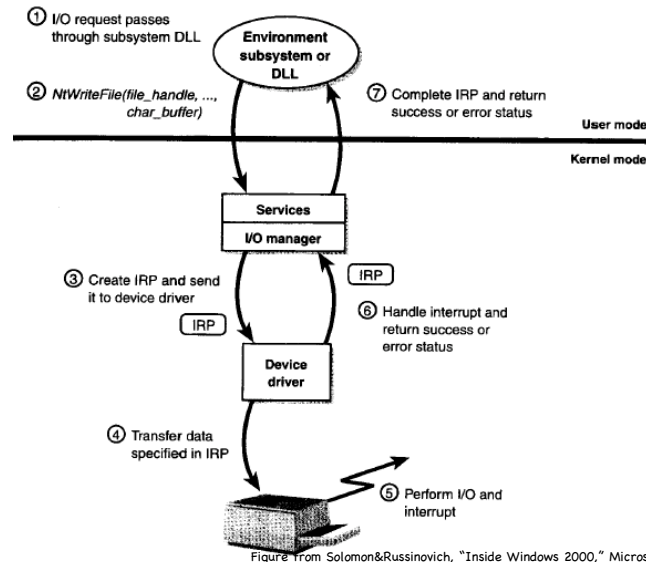
W2k I/O Processing

- Types of I/O
- I/O Control Flow

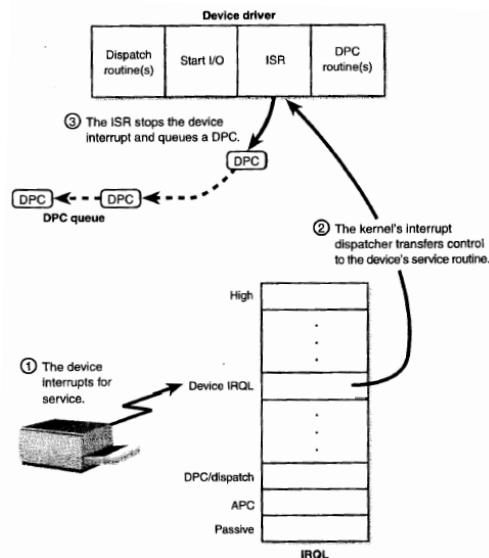
Control Flow for an IO Operation



Queuing and Completing a Synchronous Request



Servicing a Device Interrupt (only Phase I)



Servicing a Device Interrupt (Phase II)

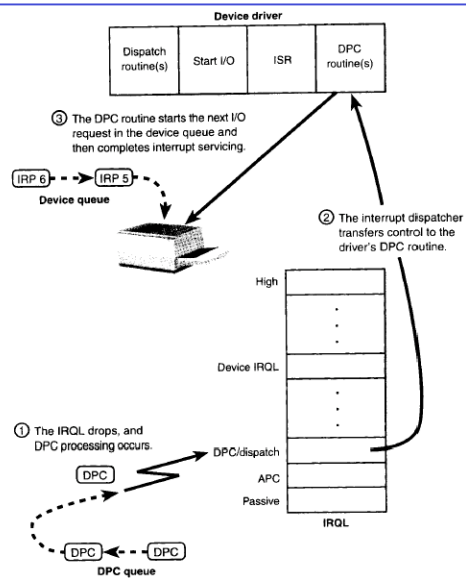


Figure from Solomon&Russinovich, "Inside Windows 2000," Microsoft Programming Series

Completing an I/O Request (Phase I)

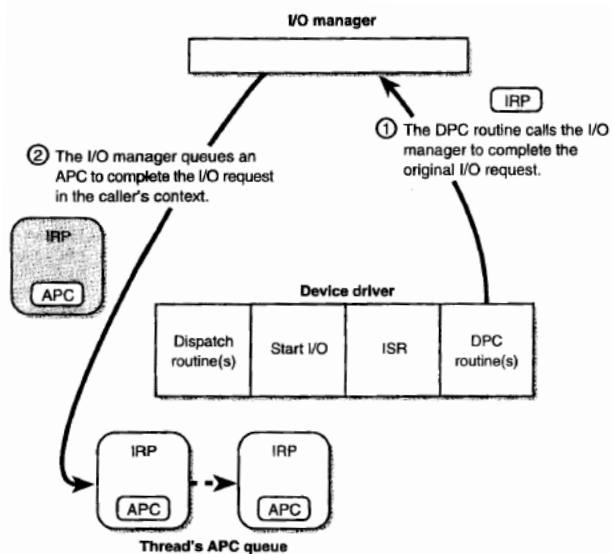


Figure from Solomon&Russinovich, "Inside Windows 2000," Microsoft Programming Series

Completing an I/O Request (Phase II)

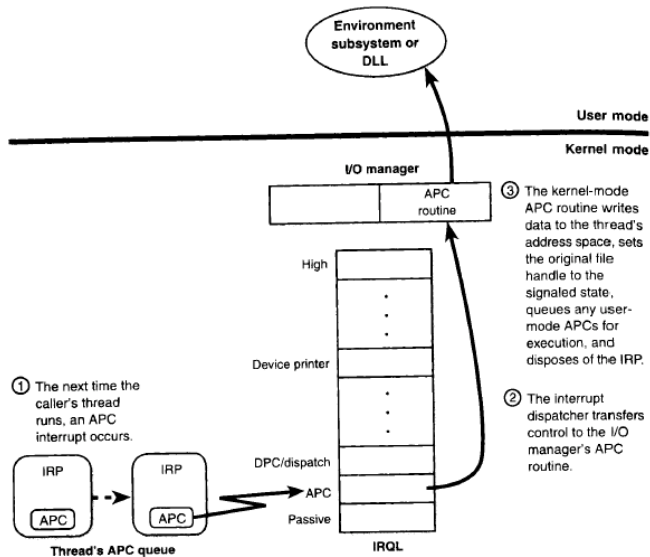


Figure from Solomon&Russinovich, "Inside Windows 2000," Microsoft Programming Series

Issues: Buffering

