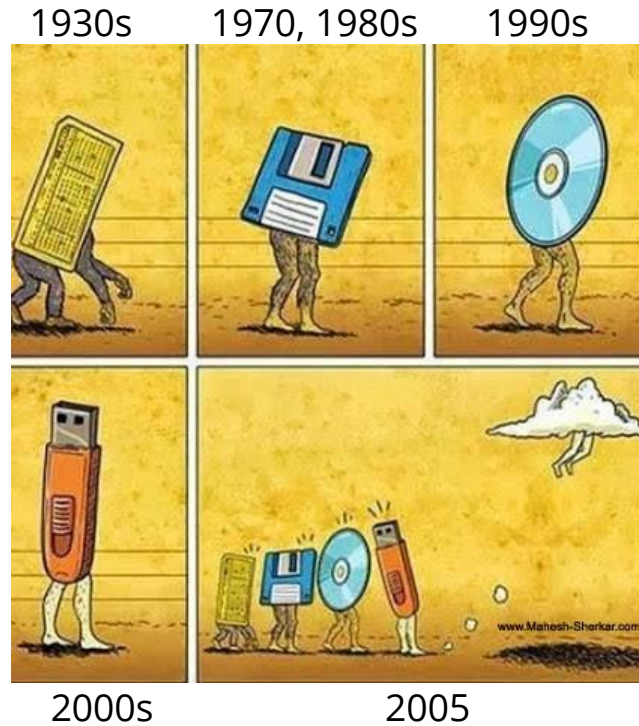




# Filesystem Implementation



# Evolution of Secondary Storage



# Filesystem Implementation

1. **Internal structure** of files / directories
2. (De)**Allocation** of space for files on physical data disk/data storage
3. **Map logical** file structure to **physical** blocks of bytes on secondary-storage devices
4. Filesystem **formats** (disk block "*floor plans*")
5. Data **Recovery**



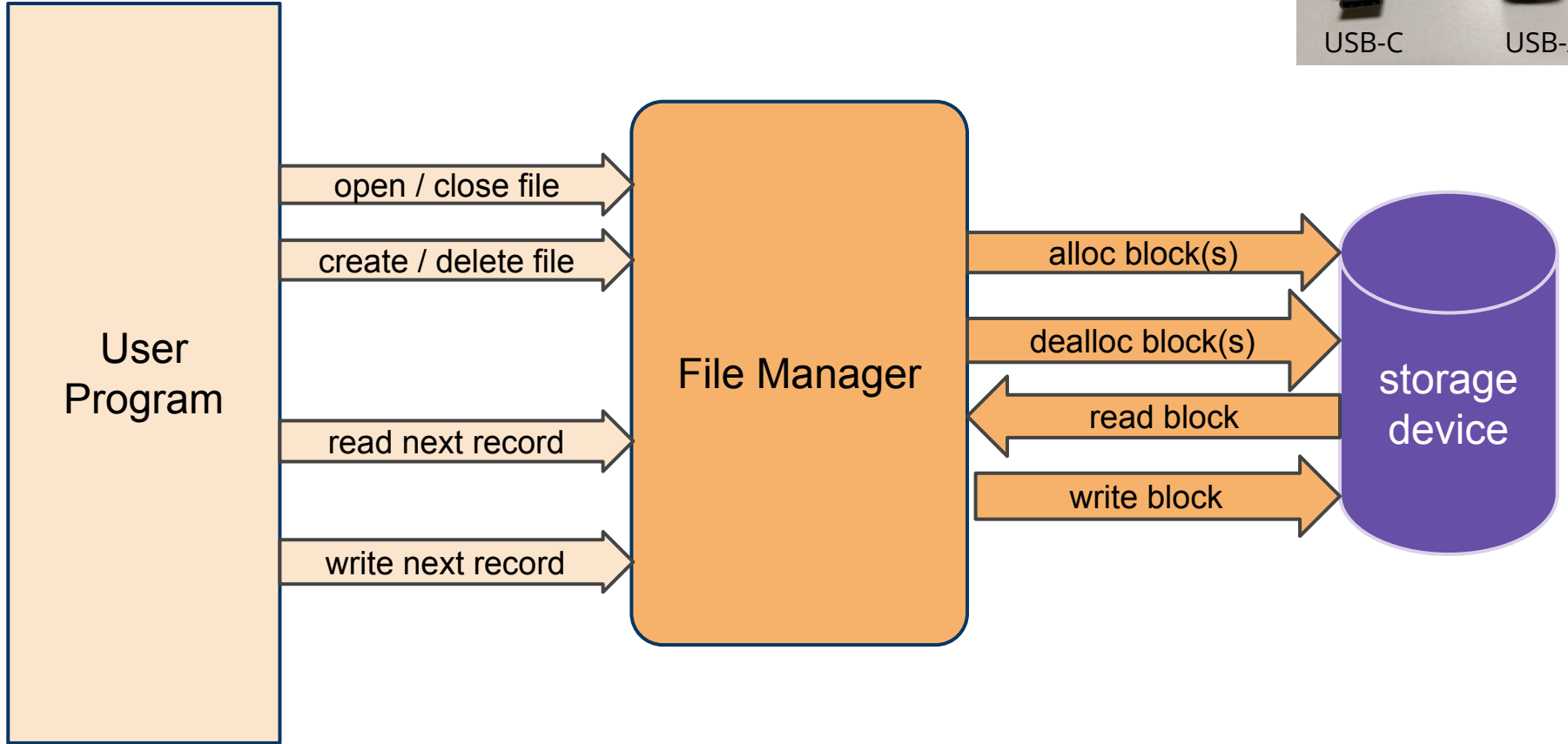
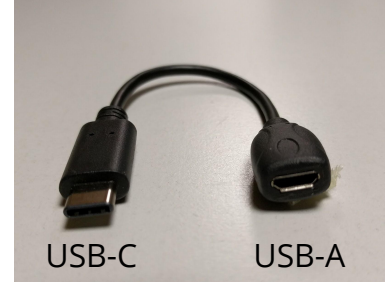
**SSD vs HDD**



# Filesystem Illusions

- Illusion #1: data in my files are stored **contiguously**
- Illusion #2: data in my files are stored in **a single** physical device
- Illusion #3: data in my files are saved to a **non-volatile** storage
  - Fact: they aren't, live CDs use ramfs (RAM FileSystem)

# File Manager as an Adapter



*block = one or more "disc" sectors/blocks*

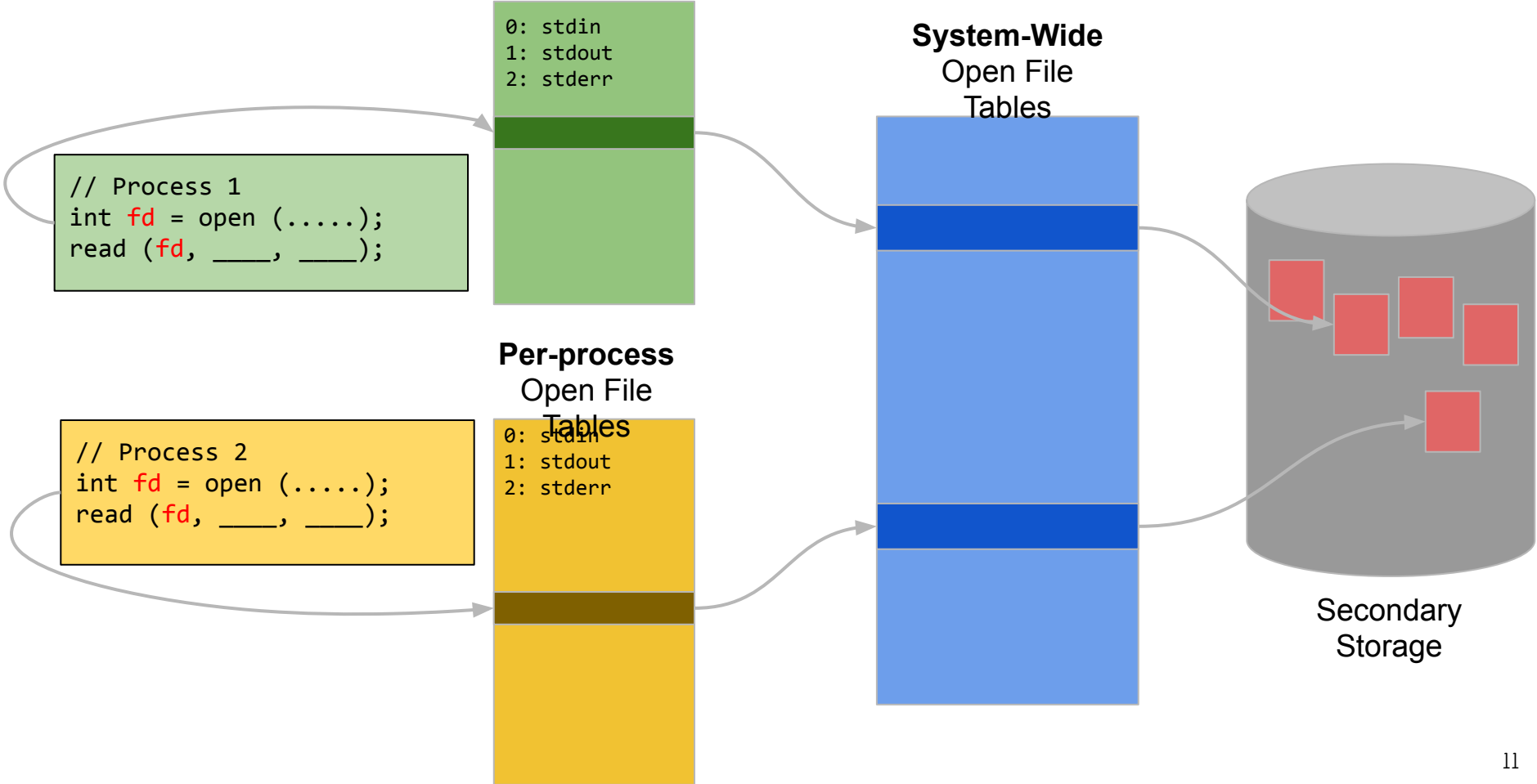
# Data Structures for File Management

- **Persistent:** On-Disk Data Structures
  - Boot record
  - Partition Table
  - Filesystem attributes (number of blocks, size per block, free-block count, free-block pointers, ....)
  - Hierarchical Directory Structure
- **Transient:** In-Memory Data Structures
  - Table of open files (per process & system-wide)
  - Table of mounted volumes
  - Inserting USB/CD, Unix mount cmd

# PCB vs FCB

- PCB (Process Control Block): table of “**active**” processes
  - Owner of process
  - Current context (stack pointer, registers, ....)
  - Location of processes (in virtual memory)
- FCB (File Control Block): table of **opened** files
  - Owner of the file
  - Current context (file pointer, status of operations)
  - Location of R/W buffer
  - Location of files (in secondary storage)

# File Descriptors / File Handles

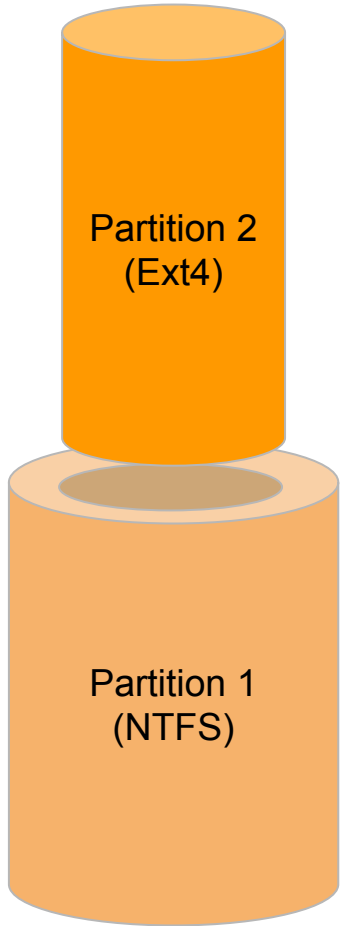




# Partition Layouts

Type	Max Partitions	Address	Max Capacity	
			With 512-byte blocks	With 4K-byte clusters
MBR	4	32 bits	$2^{32} \times 2^9 = 2^{41} = 2 \text{ TB}$	$2^{32} \times 2^{12} = 2^{44} = 16 \text{ TB}$
GPT	128	64 bits	$2^{64} \times 2^9 = 2^{73} = 8 \text{ ZB}$	$2^{64} \times 2^{12} = 2^{76} = 64 \text{ ZB}$

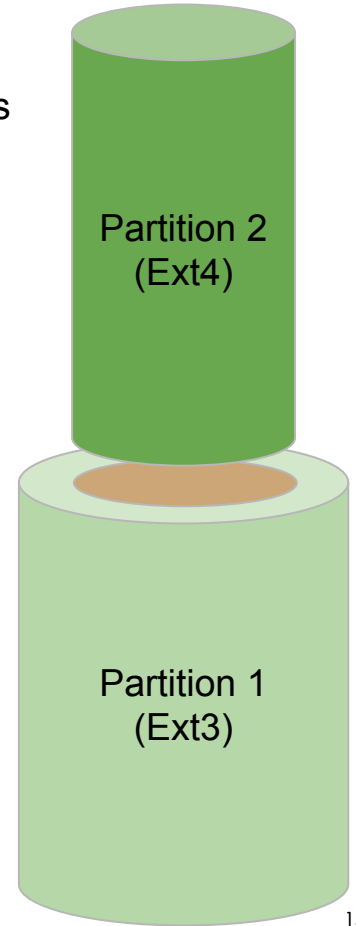
# Example: One Physical Disc, Two Partitions



Boot Linux from  
Partition 2

Boot Windows  
from Partition 1

Home directories  
in Partition 2



Boot Linux  
from Partition 1

Format  $\approx$  **Layout** (Building/Space/Room)

**meijer**

**Walmart** 



# File Format vs FileSystem Format

- Various **formats** of image files:JPG, PNG, BMP, TIFF, ....
- General sections of an image file
  - Header/Metadata: image size, number of bits per pixel, colormap, compression table, ...
  - Data: binary pixel data
- Layout of a **file**

## File(system) Format

- Metadata: filesystem size, number of blocks, number of freeblocks, number of index blocks, list of free data blocks, list of free index blocks, ....
- Data: boot record, index blocks, data blocks
- Layout of a **disk partition**