hhuOS

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Facts about hhuOS

- A small operating system for teaching and learning purposes
- written for x86 32-bit architecture
- written in C++ and x86-Assembler using gcc and nasm
- Open-Source, published under the GPL v3 license
- ~ 25000 lines of code

hhuOS - Features

- Processes & Threads
  - Round-Robin based preemptive scheduling
  - Binary files are executed as processes
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  - Each process has its own address space
- Adress spaces and memory management
  - Using x86-Paging mechanism (virtual/physical memory)
  - Lazy mapping implementation
  - Kernel address space is always mapped at 3 GiB (not accessible from user space)
  - Different memory managing algorithms are implemented (Free List, Bitmap, Table)

hhuOS - Features

- Unified Library
  - Single codebase for user- and kernel-space library
  - Functions requiring kernel access are outsourced into an interface (implemented two time - for kernel and user space)
  - Kernel access from user space via system calls (software interrupts)

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- Unified Library
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- Further features
  - Virtual Filesystem (can mount physical filesystems)
  - Hardware support (Keyboard, PCI, Floppy AHCI, VESA & CGA Graphics)
  - Compatible with UEFI and BIOS systems (BIOS calls are supported)
  - Own UEFI bootloader (towboot, developed by Niklas Sombert)
  - Experimental support for networking, thanks to several bachelors thesis (2 drivers and a UDP/IP Stack)

Overview: Memory & Paging

- Paging: Abstract physical memory from virtual address spaces
- New pages can be mapped in/out dynamically
- Use of different address spaces for process separation
- Kernel is mapped at 3 GiB $\rightarrow$ Higher-Half-Kernel (always visible)
- Adresses below 3 GiB are used for user space memory

Paging: The boot process

- How to allocate memory when no memory manager is available?
- How to map the Kernel-code at 3 GiB without losing the EIP?
- Solution: Activate paging in several steps

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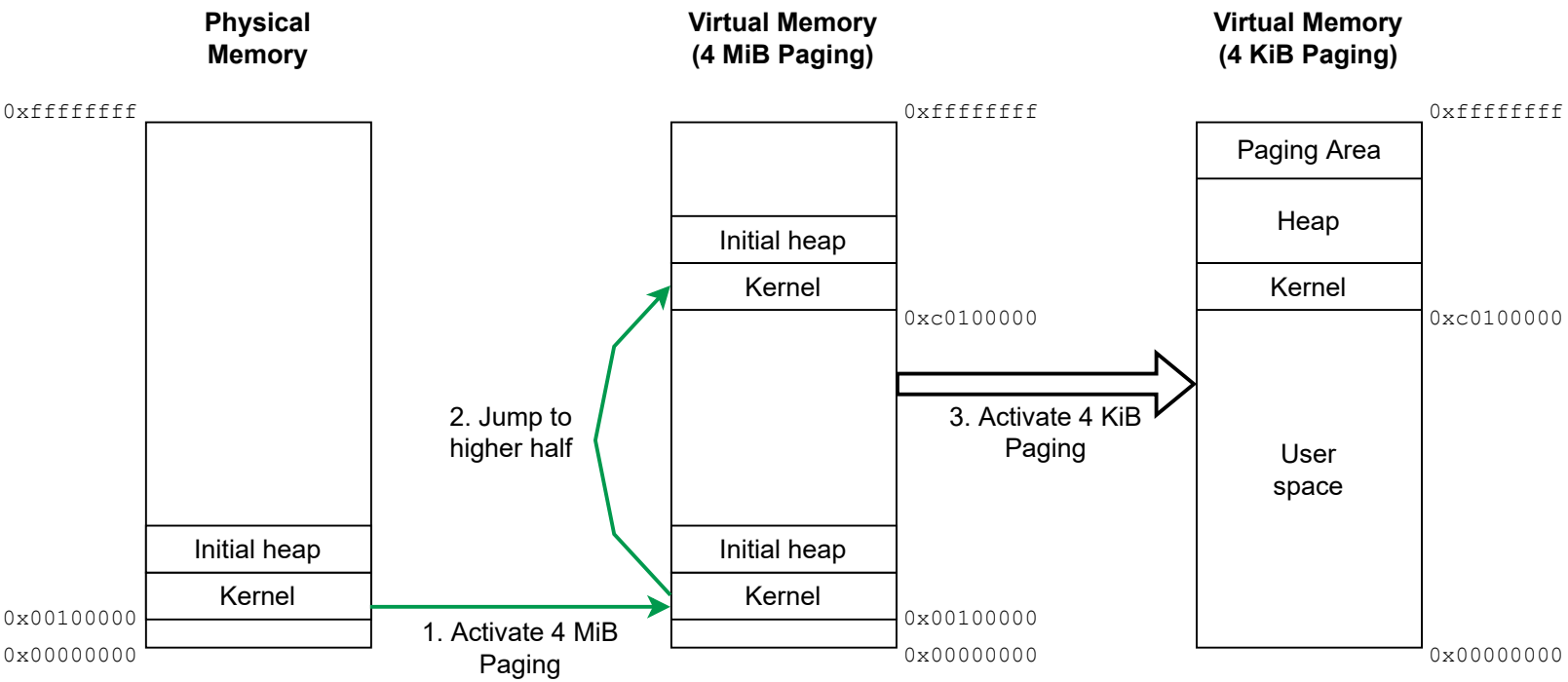

Allocating heap memory

1. Invoke Free list manager to find free memory block in heap
2. Slice free block (with respect to alignment)
3. Return pointer to found block
4. If the block was not previously mapped, the first access will generate a pagefault
5. Fault handler is invoked during interrupt handling
6. Search unused pageframe and map it to the virtual fault address
7. Return to program

Storage Devices

- *StorageDevice* as interface for block devices
- Only 4 methods: *getSectorCount()*, *getSectorSize()*, *read()*, *write()*
- Implemented for AHCI (hard drives), Floppy, Virtual Drives, and Partitions

Virtual File System

- Overlay over physical file systems (e.g. FAT)
- Storage devices can be mounted to any folder
- Files and directories are represented by `Filesystem::Node` (similar to *INode*)
- Interface `Filesystem::Driver` for physical file systems
- Integrate *FatFs*[1] to support all FAT variants

[1] `http://elm-chan.org/fsw/ff/00index_e.html`

Process Scheduling

- Global scheduler manages processes in a queue
- Timer invokes scheduler every 10ms to switch to next process (and address space)
- Each process has a separate thread scheduler, switching the current thread each time the process becomes active
- Threads can be blocked and unblocked by other threads
- Threads can sleep for a defined time
- It is possible to join other threads (or processes)

Future Work

- Implement more device drivers (sound, graphics, network, etc.)
- Implement new library functions (libc, graphics/game, etc.)
- Enhance network stack
- Better scheduling (priorities, I/O management)
- New (custom) filesystems
- Multicore support
- Support modern x86-Features (Physical Address Extensions, Long mode, APIC, HPET, etc.)