

Midterm Review



Where have we been
ECE 373

Prelims

- Questions on lab, homework or class?
 - Memory maps
 - PCI connections
 - I/O ports
 - Debugging tricks
 - Delays and timers



Types of OS's in the wild

- Single-user (Phones, PC's)
- Multi-user (Servers, mainframes, "cloud")
- Real-time (Stop lights, shuttle navigation)
- Embedded (Watch, routers, car engine, mp3)



Device drivers

- The software that controls specific pieces of hardware
- API in the OS allows common interfaces for drivers
- Driver takes common commands from the OS and translates into hardware-specific stuff
- Many types of device drivers



Types of drivers

- Three main classes of drivers
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Types of drivers

- Three main classes of drivers
 - Block drivers
 - Char drivers
 - Network drivers



Types of drivers

- Three main classes of drivers
 - Block drivers
 - Char drivers
 - Network drivers
- Driver class can apply to many types of devices
 - USB device can be char, block, or network
 - Interface cards (PCIe) can be network or block
 - Graphics typically char devices



Basic module concept

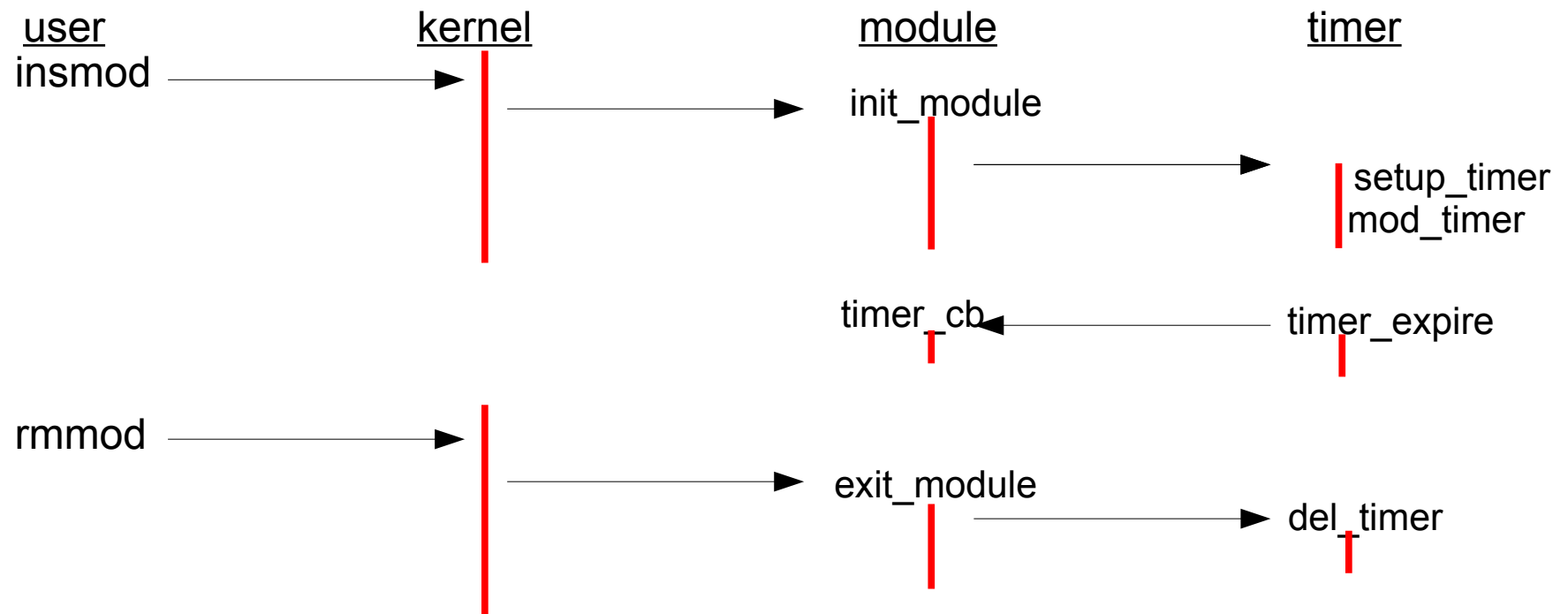
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Basic module concept

- Dynamic loading
- Registering init and exit
- Kernel timeline of module diagram



Bits and pieces

- Minimal callback hooks and Compile headers
 - Basic #includes
 - MODULE_LICENSE(lic) – legal strings
 - __init, __exit
 - module_init(func), module_exit(func)
- Time values
 - Jiffies, HZ



Module parameters

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Module parameters

- Gets info into the module
- `module_param(var, type, flags);`
- `/sys/module/<drivername>/parameters/var`
- Kernel community typically frowns on them
- `insmod <modulename> xx=11`
- `modinfo <modulename>`



Talking to the Kernel

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Talking to the Kernel

- **ioctl**
 - Older method of system call
 - Usually frowned up now-a-days
- **Netlink**
 - Newer, more flexible
 - Usually used with networking tools
- **Pseudo filesystems**
 - /proc – lots of kernel data
 - /sys – mostly module information
 - /dev – file-based connectors for read/write access
 - debugfs – useful for exposing debug hooks



Character drivers

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Character drivers

- Operate on low-bandwidth devices
- Standard callbacks
 - Open, read, write, release
- Coordinate with OS
 - `alloc_chrdev_region()`
 - `cdev`
 - `struct file_operations`
 - Linkage into `/dev`



I/O Ports



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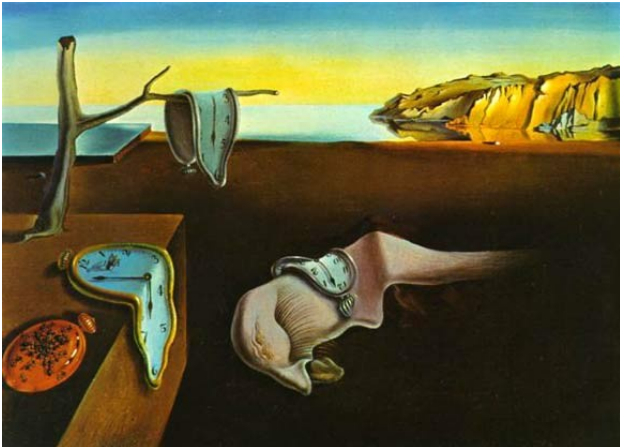
I/O Ports



- Working with slow devices
- Different "address" space from system memory
- System design coordinates device address mapping
- PC architecture evolution
 - combined many little devices into fewer large devices
 - Adds complexity to use of devices

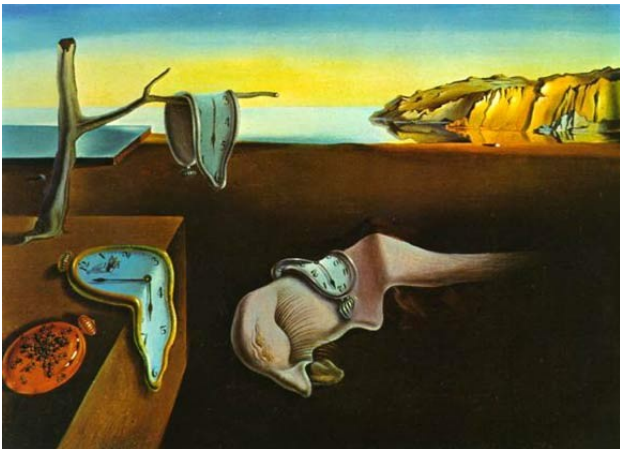
Memory Map Types

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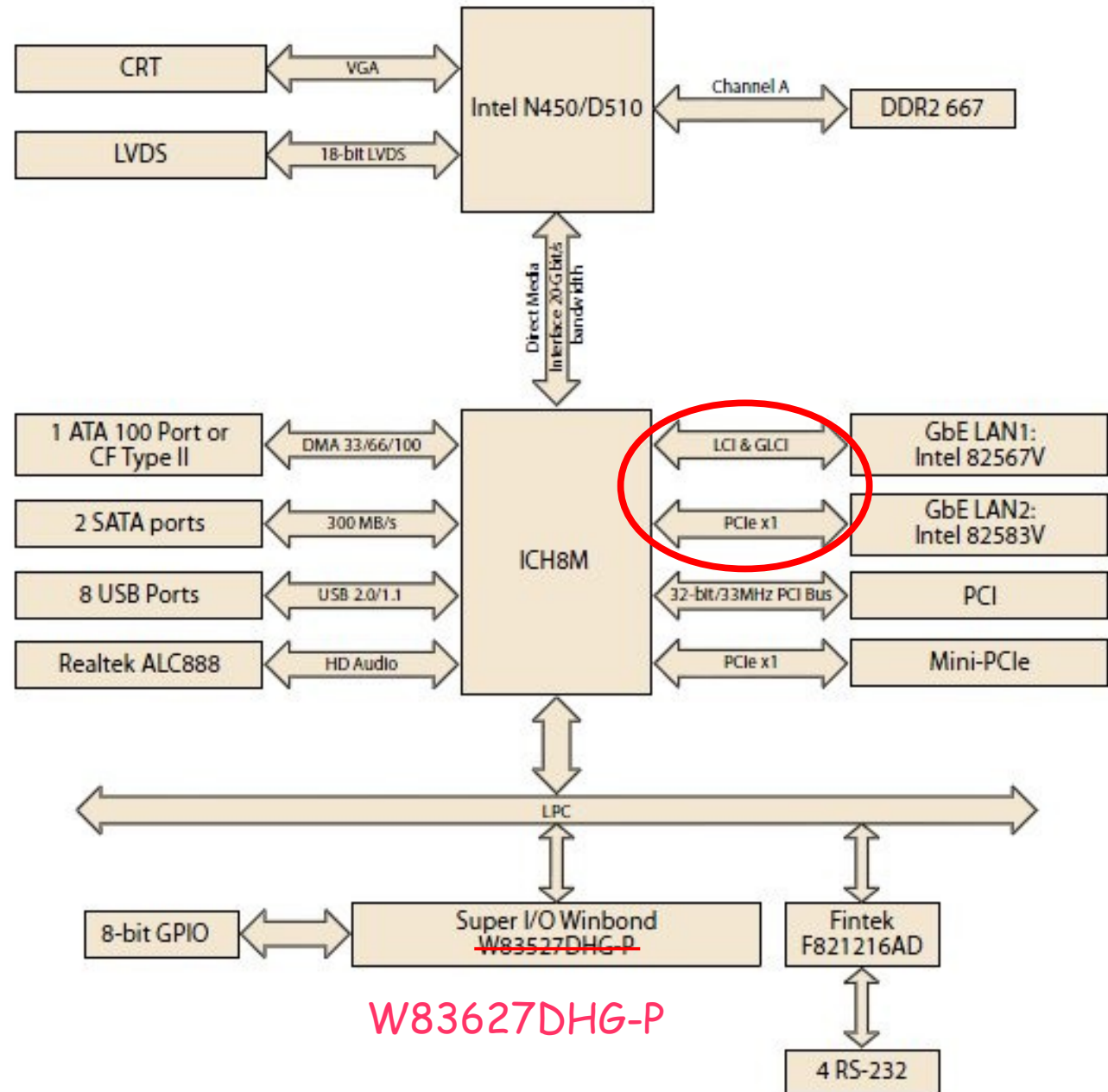
Memory Types

- Physical addresses – actual memory address
- Virtual addresses – relocatable, flexible, swappable (userspace)
- Kernel logical – maps directly to physical, used for DMA/sharing with devices
- Kernel virtual – relocatable kernel memory

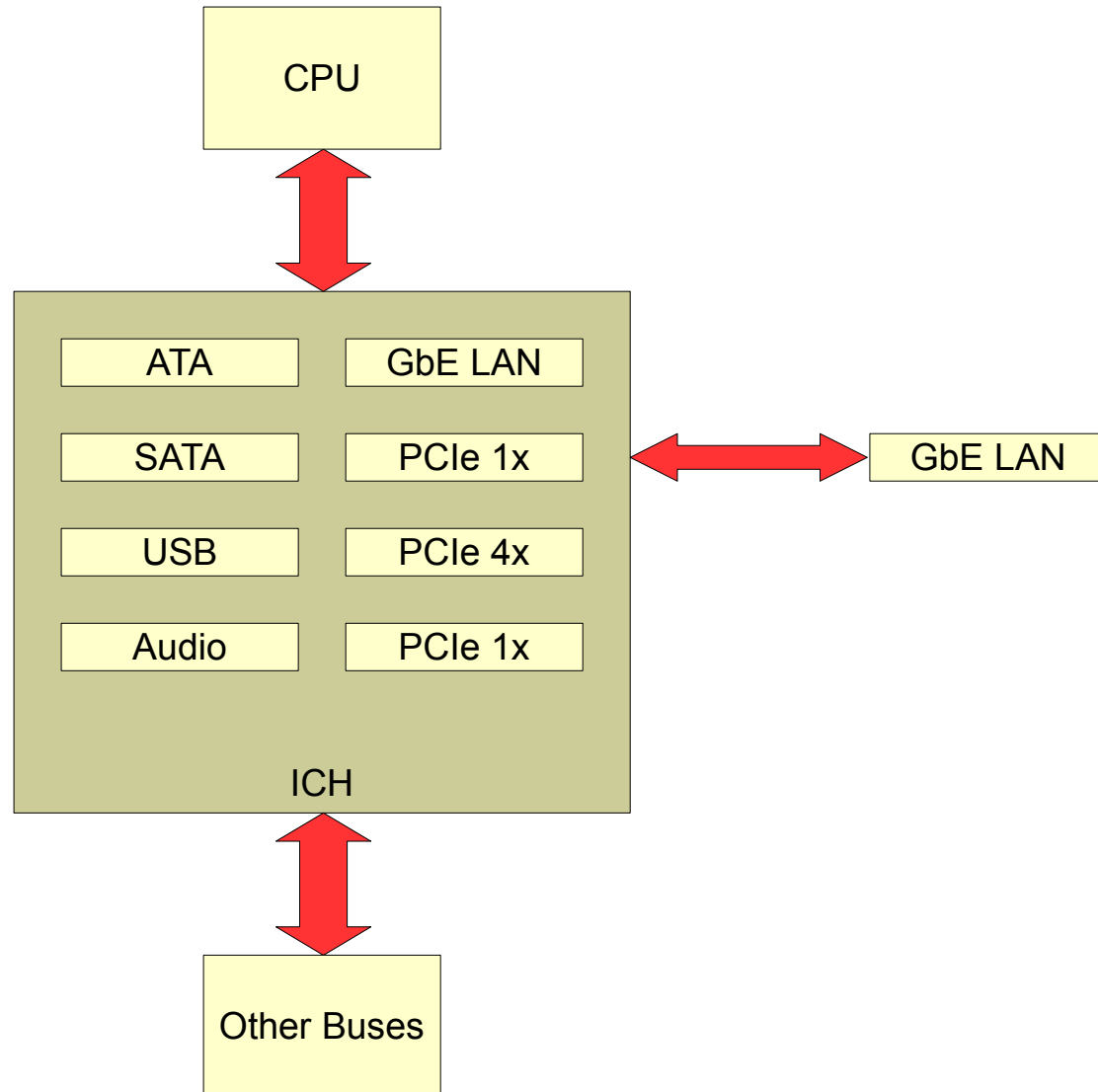


Current PCs

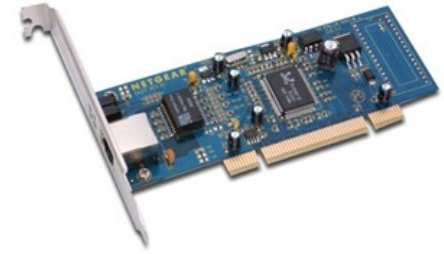
- CPU
- Chipset
- Super I/O



ICH Reality



PCI



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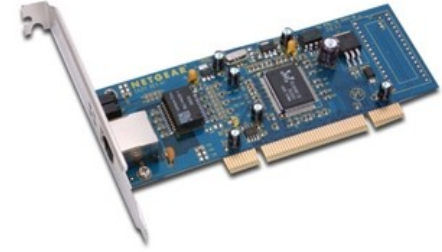
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PCI



- Communication/connection method for devices
- Devices use both port mapped and memory mapped I/O
- BAR – base address register
 - Starting address for device memory map
 - Driver uses `writel()` and `readl()` to access device registers
- Callbacks
 - Probe, remove, sleep, resume

Debugging

- Find a way to reproduce the bug
 - Gather info for tracking the problem
 - Prove it is fixed



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- Printk
 - KERN_INFO, etc
 - WARN(), BUG()



Debugging

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 - Gather info for tracking the problem
 - Prove it is fixed
- Printk
 - KERN_INFO, etc
 - WARN(), BUG(), WARN_ONCE()
- Stack trace
 - Gives idea of where things broke
 - Objdump helps decode stack info



Debugging

- Find a way to reproduce the bug
 - Gather info for tracking the problem
 - Prove it is fixed
- Printk
 - KERN_INFO, etc
 - WARN(), BUG()
- Stack trace
 - Gives idea of where things broke
 - Objdump helps decode stack info
- /proc – various kernel data for monitoring
- Kgdb – useful to break into kernel
- Ethtool – monitor network devices
- Bus trace tools



Delays and time keeping

- How jiffies relate to time
- Delays vs. Sleeping
- Pre-emption and its impacts
- `get_cycles()` and why use it



Time for Timer

- Basics
 - `setup_timer(t_var, t_callback, t_data)`
 - `mod_timer(t_var, interval)`
 - `del_timer_sync(t_var)`



Time for Timer

- Basics
 - `setup_timer(t_var, t_callback, t_data)`
 - `mod_timer(t_var, interval)`
 - `del_timer_sync(t_var)`
- Callback function
 - Called when timer expires
 - Given `t_data` as an argument
 - `timer_cb(unsigned int data)`



Getting information

- Device spec sheets
- The web
- Books
- Kernel and driver source code

