Midterm Review

Where have we been

ECE 373

Prelims

- Questions on lab, homework or class?
  - Memory types
  - PCI connections
  - 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

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  - Char drivers
  - Network drivers

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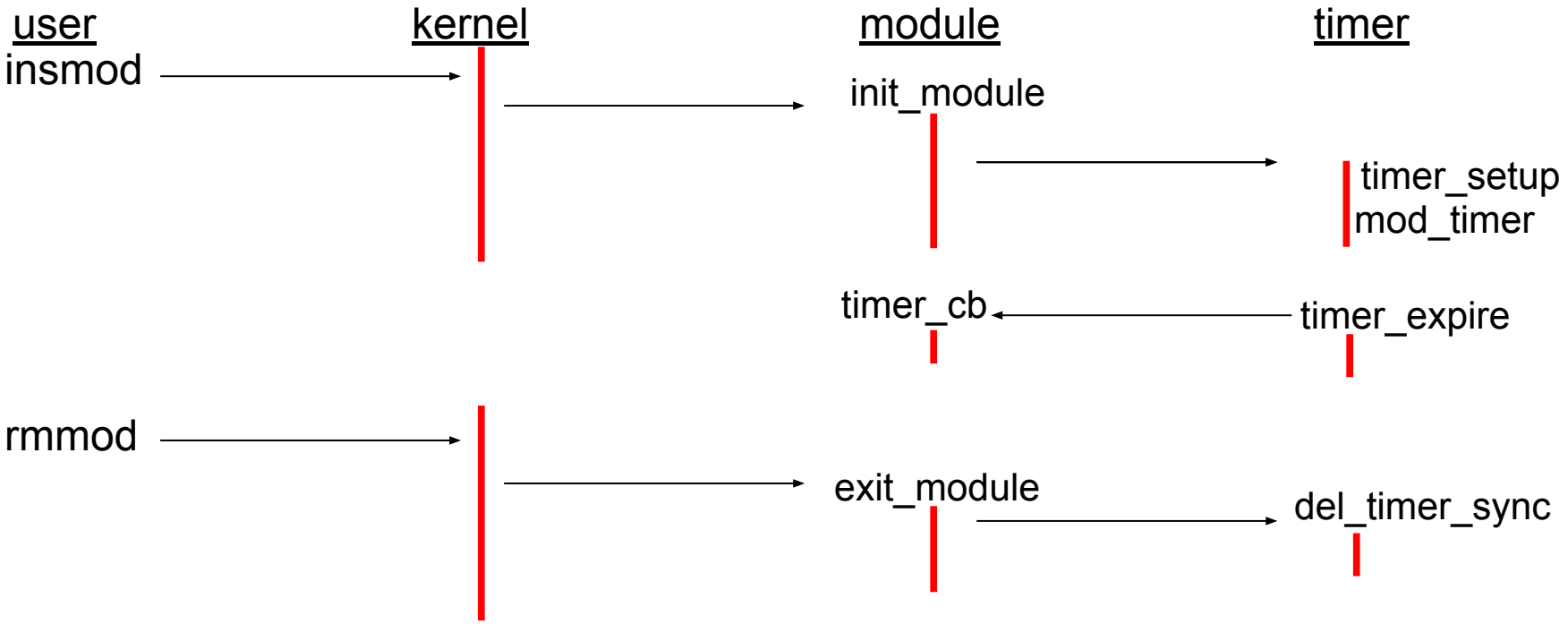
- Three main classes of drivers
  - Block drivers
  - Char drivers
  - Network drivers
- Driver class can apply to many types of devices
  - USB device can be char, block, or network
  - Interface cards (PCIe) can be network or block
  - Graphics typically char devices

Basic module concept

Basic module concept

- Dynamic loading (insmod/modprobe, rmmod)
- 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

Module parameters

- Gets info into the module
- `module_param(var, type, 0);`
- `/sys/module/<drivername>/parameters/<var>`
- Kernel community typically frowns on them
- `insmod <modulename> xx=11`
- `modinfo <modulename>`

Talking to the Kernel

Talking to the Kernel

- ioctl()
  - Older method of system call
  - Usually frowned up now-a-days (why?)
- 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

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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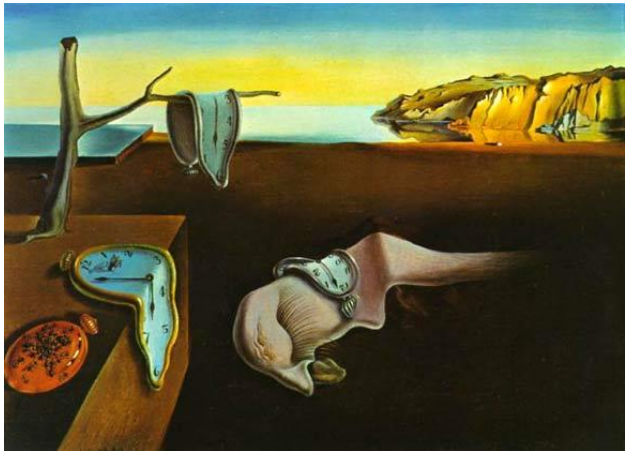
I/O Ports

- 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

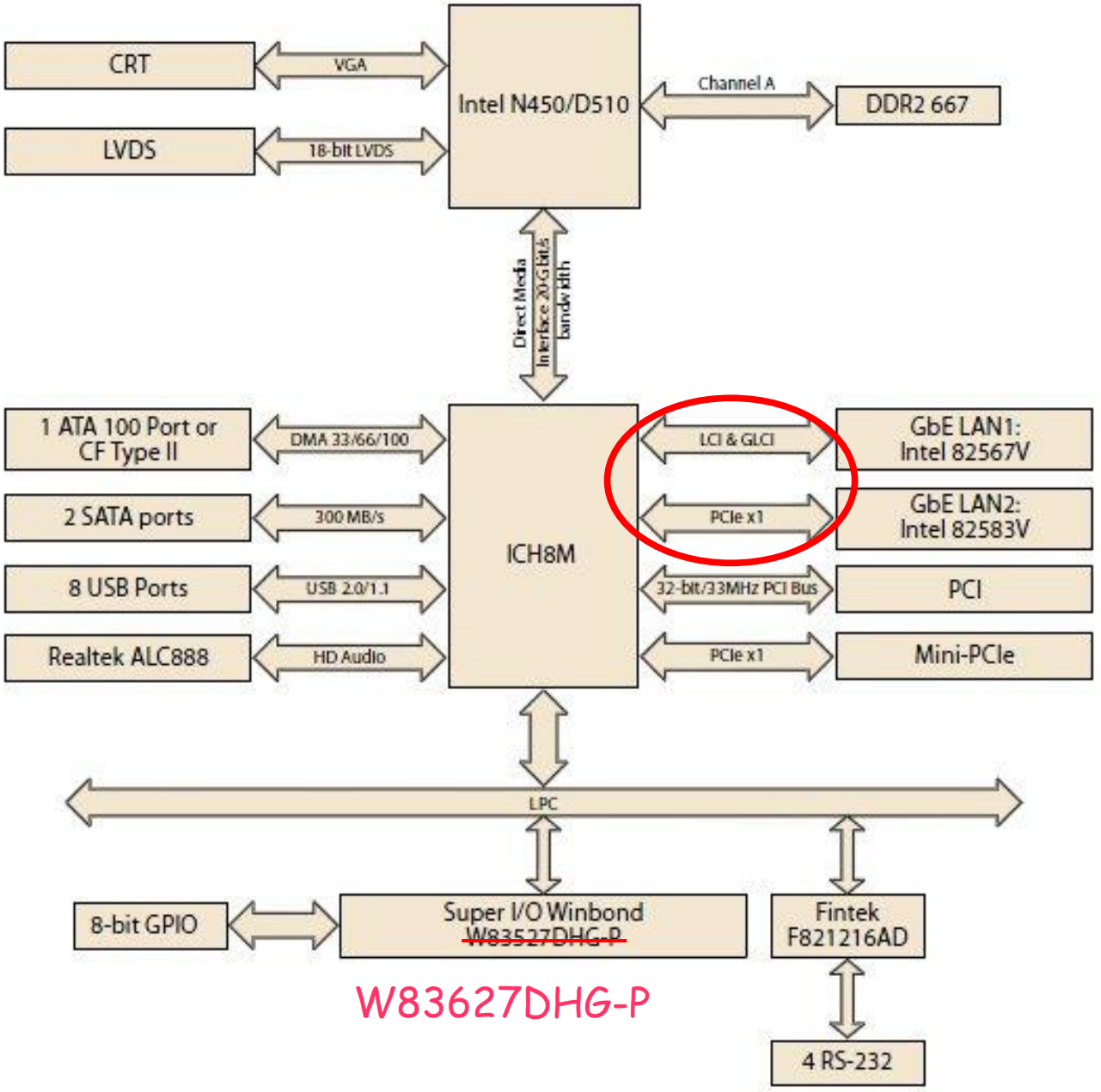
Memory Types

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



Current PCs

- CPU
- Chipset
- Super I/O



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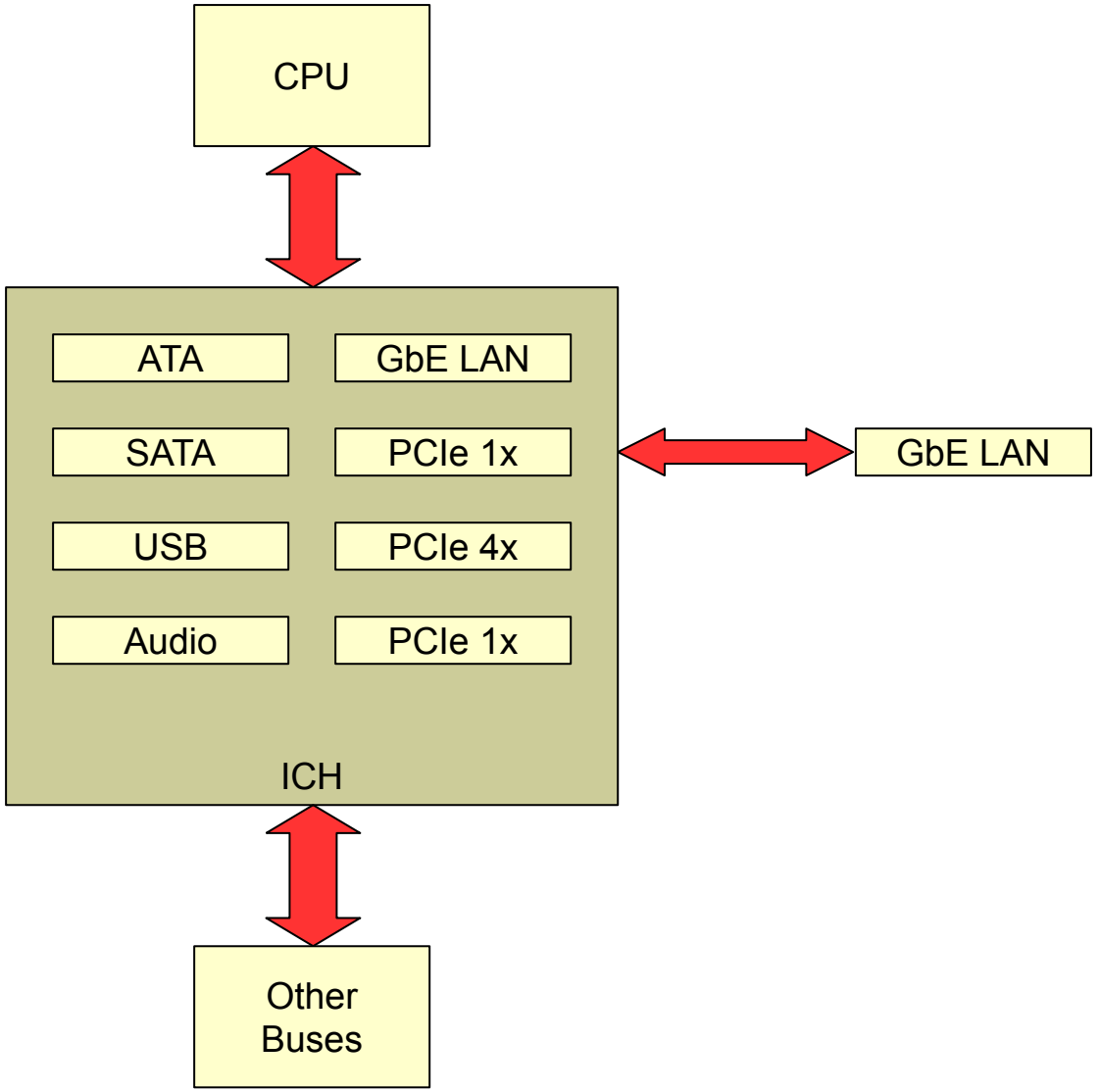
ICH Reality


CPU
ATA
GbE LAN
SATA
PCIe 1x
GbE LAN
USB
PCIe 4x
Audio
PCIe 1x
ICH
Other
Buses

PCI

PCI

- Communication/connection method for devices
- Devices use both port mapped and memory mapped I/O (focus on MMIO only for midterm)
- BAR – base address register
  - Starting address for device memory map
  - Driver uses `iowrite32()` and `ioread32()` to access device registers (or `writel()/readl()`)
- Callbacks
  - Probe, remove, sleep, resume

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  - Gather info for tracking the problem
  - Prove it is fixed

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- /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
  - `timer_setup(t_var, t_callback, t_flags)`
  - `mod_timer(t_var, interval)`
  - `del_timer_sync(t_var)`

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  - `timer_setup(t_var, t_callback, t_flags)`
  - `mod_timer(t_var, interval)`
  - `del_timer_sync(t_var)`
- Callback function
  - Called when timer expires
  - Given pointer to `t_var` as an argument
  - `timer_cb(struct timer_list *t)`
  - Use `from_timer()` to get back to private driver struct

Getting information

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