https://play.google.com/store/apps/details?id=jp.co.namura.magnifier&hl=zh_HK
https://www.pngfind.com/mpng/iRhTJTh_tux-linux-logo-start-menu-linux-icons-hd/

作業二：觀察中斷

中正大學 作業系統實驗室
指導教授：羅習五

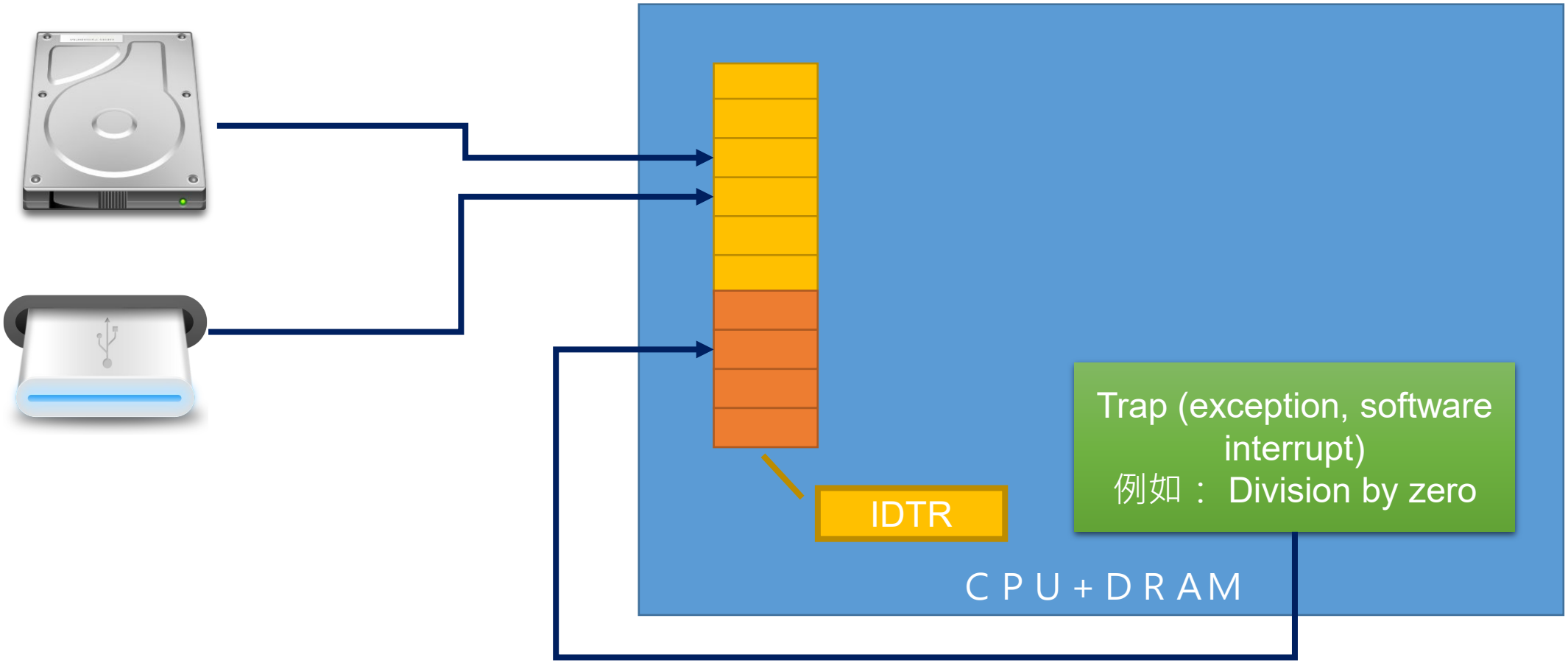
圖片來源

- 新垣結衣
  - https://makey.asia/column.php?id=532
  - http://pic.haibao.com/image/14284778.html?kw=%E6%96%B0%E5%9E%A3%E7%BB%93%E8%A1%A3
  - https://huaban.com/pins/835412722/

作業目標及負責助教

- 作業目標：
  - 了解Linux怎樣設定中斷向量表
  - 了解驅動程式中，關於中斷的部分
  - 了解如何追蹤Linux、反組譯等技巧
- 負責助教：
  - 請看網頁

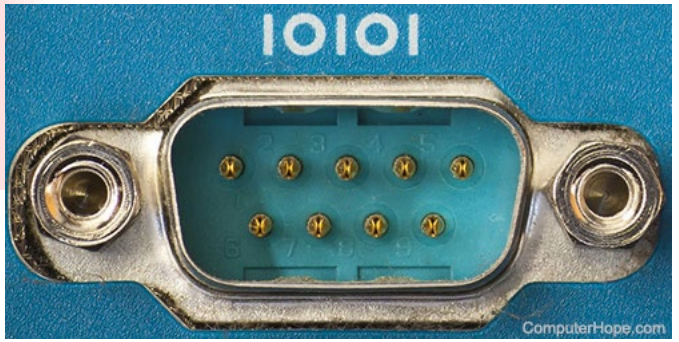
從硬體看x86的中斷



從「軟體」看x86的中斷

1. 怎麼樣向OS註冊中斷?
2. 中斷向量的運作流程?

1. 怎麼樣向OS註冊中斷?

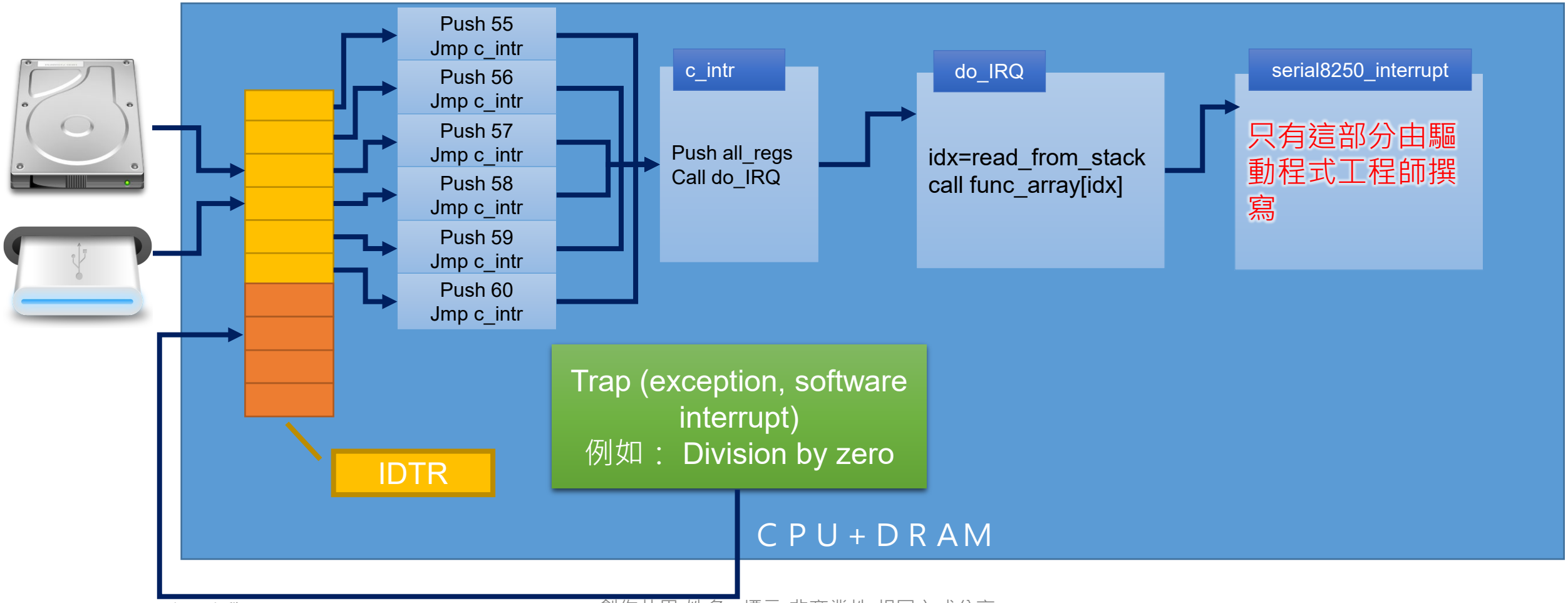


- API: request_IRQ
  - 這部分的投影片都以serial8250為例，這是很簡單的驅動程式
  - 軟硬體都很簡單，幾乎不會出錯，因此常常用來做OS的除錯工具
  - ret = request_irq(up->port.irq, serial8250_interrupt,
    irq_flags, up->port.name, i);
  - 在這個例子中，最重要的參數是 serial8250_interrupt ， 請注意這是一個C 函數

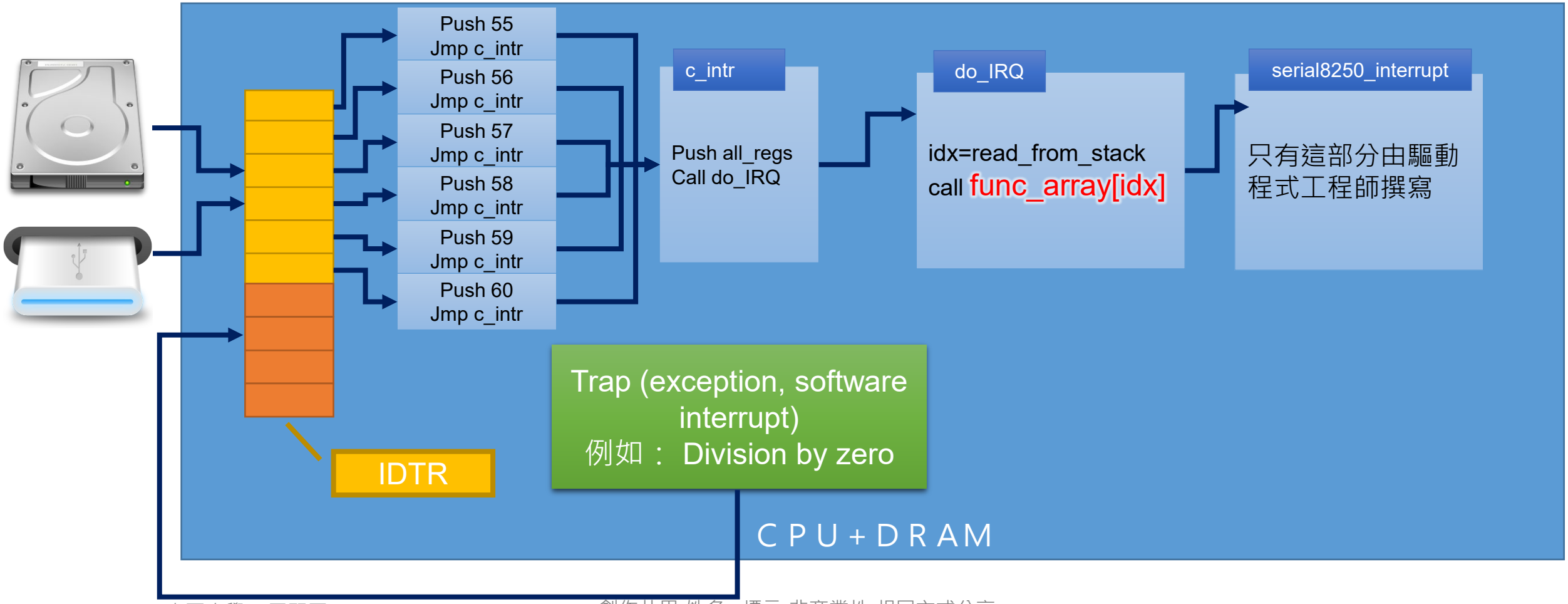
2. 中斷向量的運作流程?

- 對驅動程式設計師而言，只要硬體發生中斷，那麼OS就會呼叫「serial8250_interrupt」，大部分的驅動程式都是用「C」撰寫而成
- 幾乎沒人用組合語言，組合語言的部分、CPU直接相關的部分，都由Linux代為處理

從OS開發者看中斷流程



從OS開發者看「註冊中斷」



關於堆疊

- 不管是system call、trap、interrupt，在呼叫第一個C函數時，堆疊一定是長這樣子

```
struct pt_regs {
/*
 * C ABI says these regs are callee-preserved. They aren't saved on kernel entry
 * unless syscall needs a complete, fully filled "struct pt_regs".
 */
        unsigned long r15;
        unsigned long r14;
        unsigned long r13;
        unsigned long r12;
        unsigned long rbp;
        unsigned long rbx;
/* These regs are callee-clobbered. Always saved on kernel entry. */
        unsigned long r11;
        unsigned long r10;
        unsigned long r9;
        unsigned long r8;
        unsigned long rax;
        unsigned long rcx;
        unsigned long rdx;
        unsigned long rsi;
        unsigned long rdi;
/*
 * On syscall entry, this is syscall#. On CPU exception, this is error code.
 * On hw interrupt, it's IRQ number:
 */
        unsigned long orig_rax;
/* Return frame for iretq */
        unsigned long rip;
        unsigned long cs;
        unsigned long eflags;
        unsigned long rsp;
        unsigned long ss;
/* top of stack page */
};
```

作業系統概論基於GNU/Linux

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Intel的系統暫存器

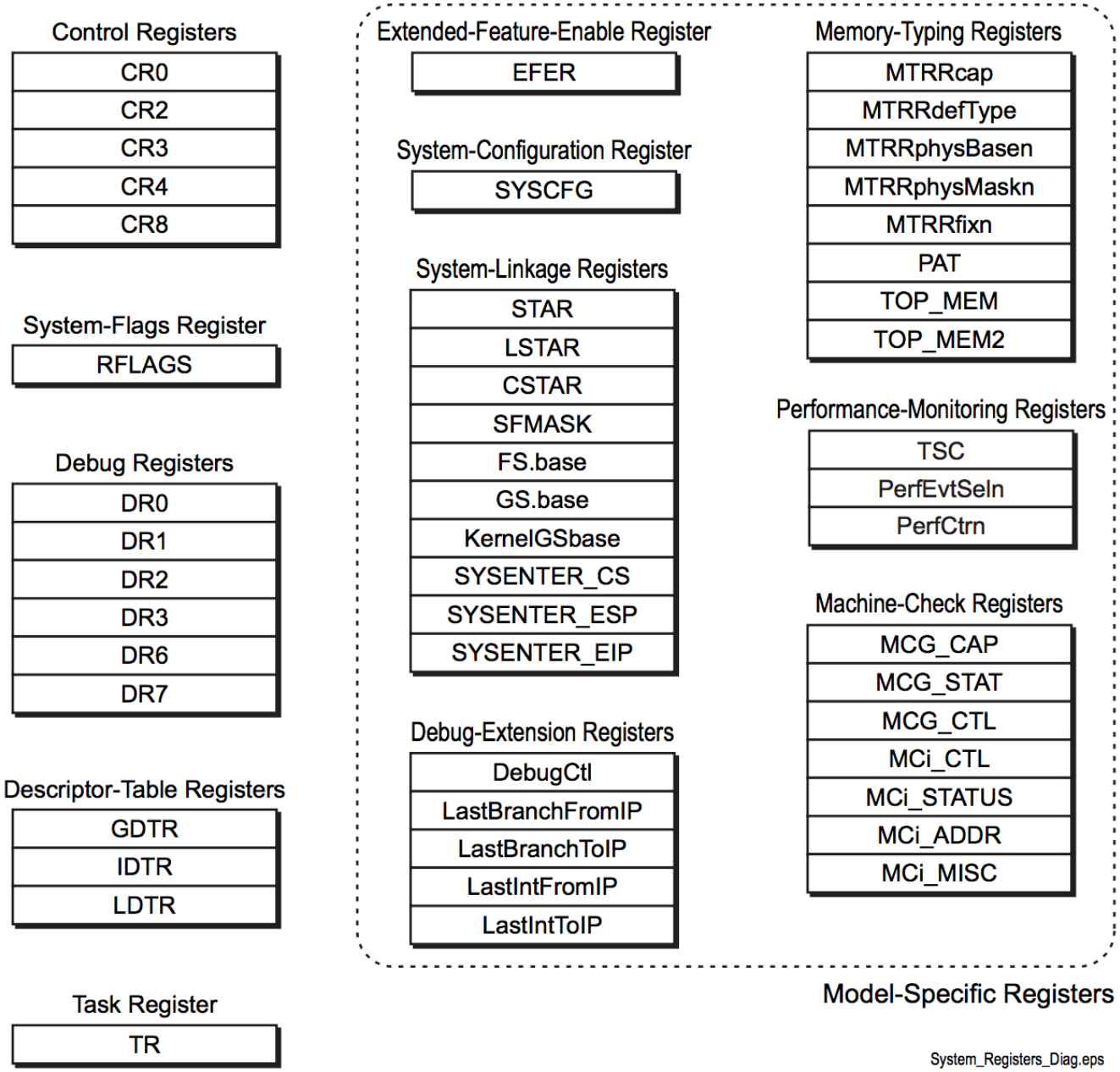

Figure 1-7. System Registers

- 大概介紹86的語法
  - https://software.intel.com/content/www/us/en/develop/articles/introduction-to-x64-assembly.html?wapkw=