

資訊專案開發與實作

Hypervisor開發與Linux、即時系統整合

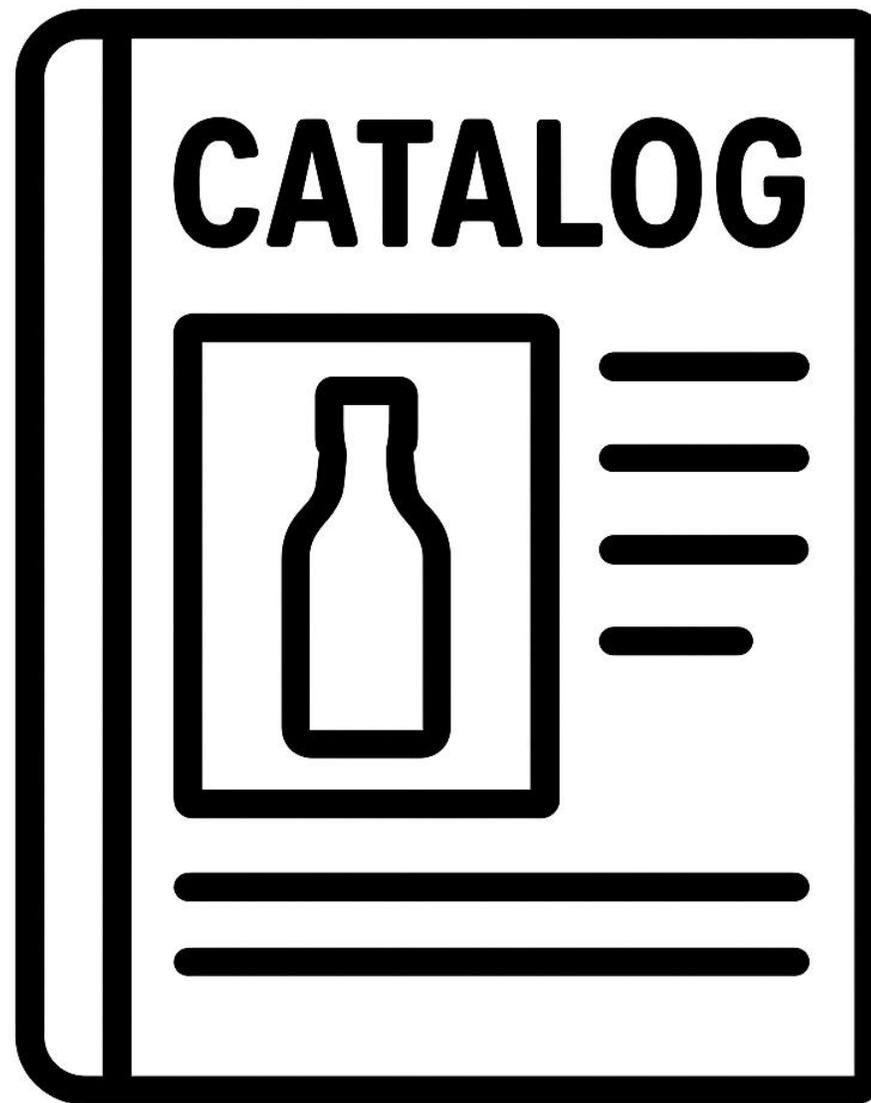
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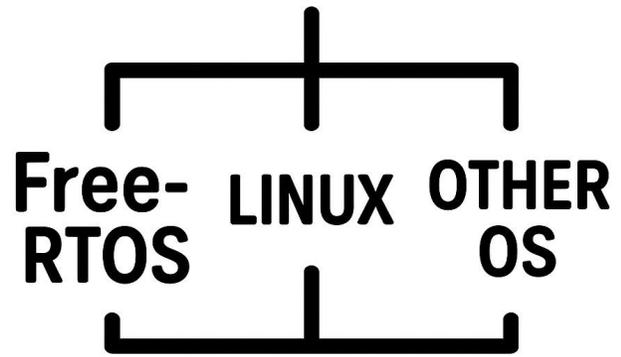
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- 專案簡介
- 遭遇困難
- 成果展現
- 未來展望



專案簡介

HYPERVERSOR



遭遇困難

解決專案相容的問題

FreeRTOS

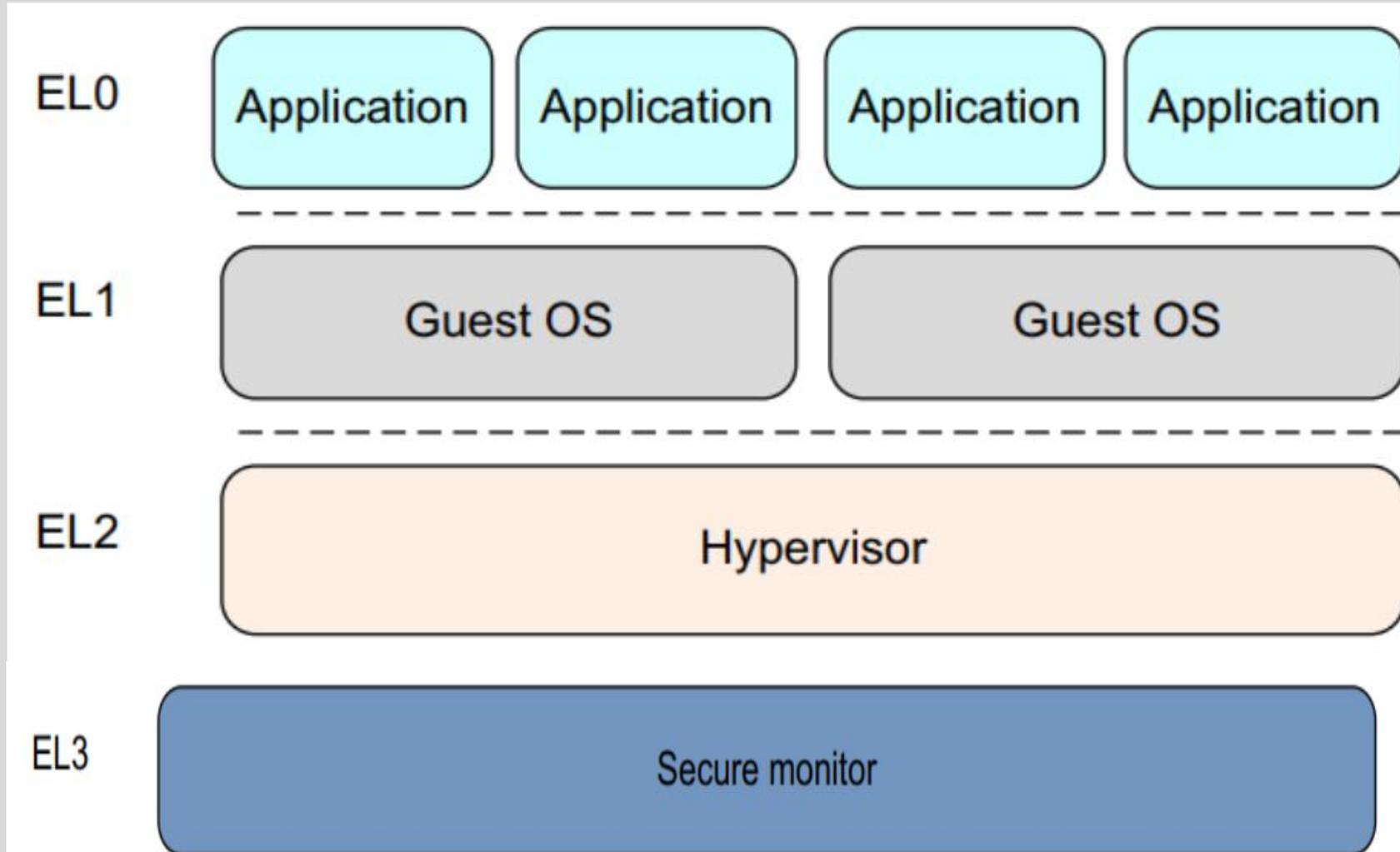
V.S.

Raspvisor
(HYPERVISOR)

差異點:

- **Initial point**
- **Entry point**
- **Bss 初始化**
- **Exception level**

Exception level



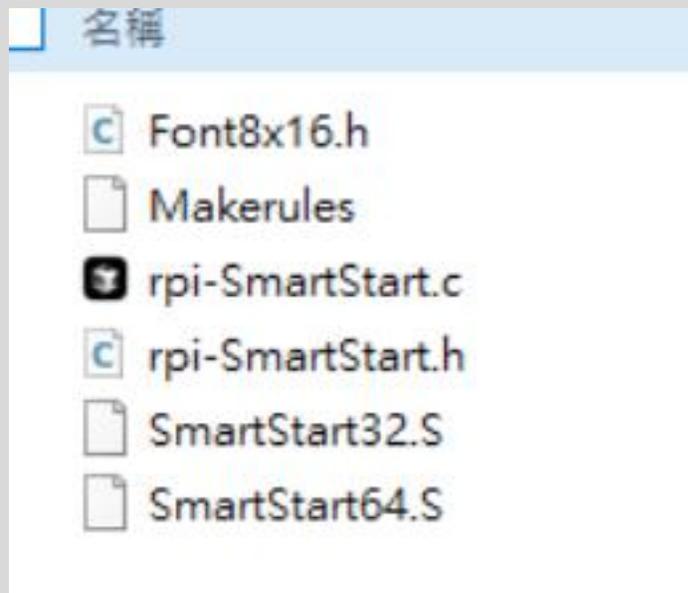
```
sctlr_el2: 30C50811
hcr_el2: 8027603B
sctlr_el2: 30c50811
hcr_el2: 8027603b
INFO[1]: loading...
INFO[1]: loaded
Kernel process started. EL 1
```

User process

```
12INFO[2]: loading...
INFO[2]: loaded
INFO[3]: loading...
INFO[3]: loaded
!!! PANIC[3]: uncaught synchronous exception:
Instruction Abort from a lower Exception level.
esr: 82000007, address: 200
```

解決問題:

Loader的改寫



| 名稱 | 修改日期 | 類型 | 大小 |
|------------------|--------------------|------------------|-------|
| arm | 2025/5/10 上午 02:23 | 檔案資料夾 | |
| include | 2025/5/10 上午 02:37 | 檔案資料夾 | |
| boot.S | 2025/5/10 上午 02:24 | Assembler Source | 1 KB |
| context_switch.S | 2025/5/10 上午 02:44 | Assembler Source | 3 KB |
| Font8x16.h | 2025/5/10 上午 02:00 | C Header 來源檔案 | 17 KB |
| linker.ld | 2025/5/10 上午 02:30 | LD 檔案 | 1 KB |
| Makerules | 2025/5/10 上午 02:45 | 檔案 | 1 KB |
| memzero.c | 2025/5/10 上午 02:27 | C file | 1 KB |
| mini_uart.c | 2025/5/10 上午 02:34 | C file | 3 KB |
| SmartStart32.S | 2025/5/10 上午 02:00 | Assembler Source | 38 KB |
| SmartStart64.S | 2025/5/10 上午 02:00 | Assembler Source | 31 KB |
| timer_irq.c | 2025/5/10 上午 02:37 | C file | 4 KB |
| uart_compat.h | 2025/5/10 上午 02:27 | C Header 來源檔案 | 1 KB |
| utils.S | 2025/5/10 上午 02:25 | Assembler Source | 1 KB |

新舊語法特點

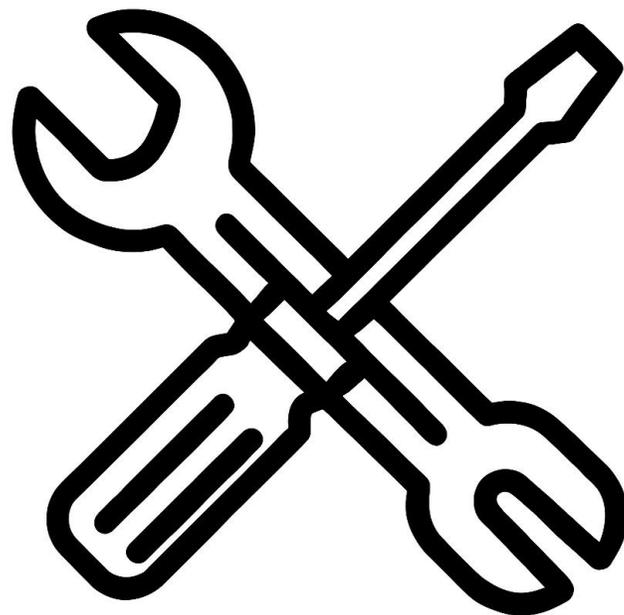
```
// 簡潔明確的函式宣告
void uart_send(char c)
{
    while(1) {
        if(get32(AUX_MU_LSR_REG) & 0x20)
            break;
    }
    put32(AUX_MU_IO_REG, c);
}

// 分組相關功能
void uart_init(void)
{
    unsigned int selector;
    // 配置GPIO和UART設置
    // ...
}
```

```
// 複雜的聯合結構與詳細註解
typedef union
{
    struct
    {
        unsigned unused : 1;
        unsigned Counter32Bit : 1;
        false)
        TIMER_PRESCALE Prescale : 2;
        // ...
    };
    uint32_t Raw32;
    bits as a uint32_t
} time_ctrl_reg_t;

// 大量的硬體寄存器結構定義
struct __attribute__((__packed__, aligned(4))) GPIORegisters {
    uint32_t GPFSEL[6];
    uint32_t reserved1;
    // ...
};
```

經過一番努力



Kernel process started. EL 1

User process

12INFO[2]: loading...

INFO[2]: loaded

INFO[3]: loading...

INFO[3]: loaded

345123451abcdeabcdeab23451234512cdeabcdeabc34512345123deabcdeabcd45123451234eabc
deabcde51234512345abcdeabcdea12345123451bcdeabcdeab23451234512cdeabcdeabc3451234
51234deabcdeabcd51234512345eabcdeabcde12345123451abcdeabcdeab23451234512cdeabcde
abc34512345123deabcdeabcd45123451234eabcdeabcde51234512345abcdeabcdea12345123451
bcdeabcdeab23451234512cdeabcdeabc345123451234deabcdeabcd51234512345eabcdeabcde12
345123451abcdeabcdea23451234512bcdeabcdeabc34512345123deabcdeabcd45123451234eabc
deabcde51234512345abcdeabcdea12345123451bcdeabcdeab23451234512cdeabcdeabc3451234
5123deabcdeabcd451234512345eabcdeabcde12345123451abcdeabcdea23451234512bcdeabcde
ab34512345123cdeabcdeabcd45123451234eabcdeabcde51234512345abcdeabcdea12345123451
bcdeabcdeab23451234512cdeabcdeabc34512345123deabcdeabcd451

```
sctlr_e12: 30C50811
hcr_e12: 8027603B
sctlr_e12: 30c50811
hcr_e12: 8027603b
INFO[1]: loading...
INFO[1]: loaded
Kernel process started. EL 1

User process

12INFO[2]: loading...
INFO[2]: loaded
INFO[3]: loading...
INFO[3]: loaded
345123451abcdeabcdeab23451234512cdeabcdeabc34512345123deabcdeabcd45123451234eabcdeabcde512345123
3451234512cdeabcdeabc34512345123deab
switched to 2
Exception level: 1

this is raspvisor switch system test!
```

```
hcr_el2: 8027603b
INFO[1]: loading...
INFO[1]: loaded
Kernel process started. EL 1
```

User process

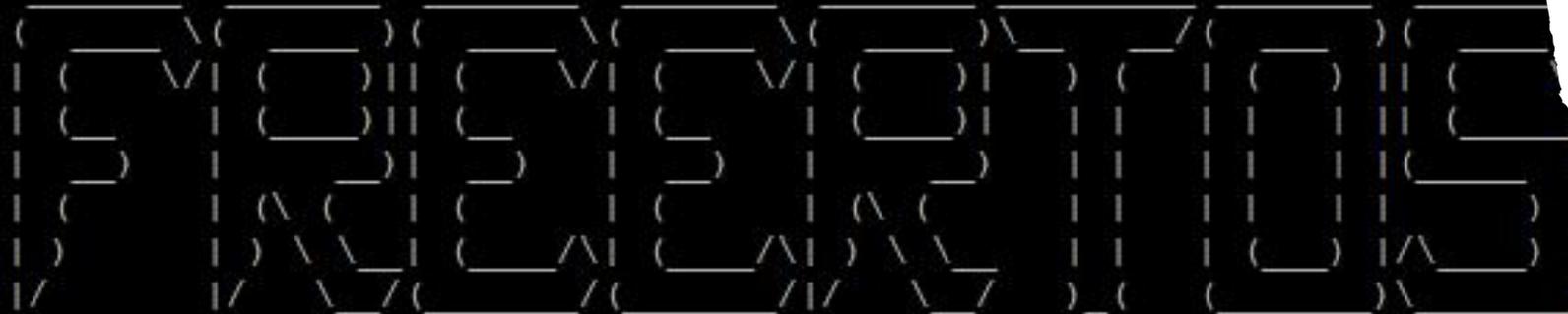
```
12INFO[2]: loading...
INFO[2]: loaded
INFO[3]: loading...
INFO[3]: loaded
3451
switched to 3
```

==== FreeRTOS =====

```
( _ \ ( _ ) ( _ \ ( _ \ ( _ ) \ / ( _ ) ( _ \
| ( _ \ | ( _ ) || ( _ \ | ( _ \ | ( _ ) | ) ( _ | ( _ ) || ( _ \
| ( _ | ( _ ) || ( _ | ( _ | ( _ ) | | | | | | | | ( _ )
| ( _ | ( _ ) | ( _ ) | ( _ ) | ( _ ) | | | | | | | | ( _ )
| ) | ) \ \ | ( _ ^ | ( _ ^ | ) \ \ | | | ( _ | ^ ) |
| / | / \ / | ( _ / | ( _ / | / \ / | ) ( _ ) \ )
```

按下 Enter 鍵繼續...

```
===== FreeRTOS =====
```



```
按下 Enter 鍵繼續...
```

```
=== raspvisor ===
```

```
sctlr_el2: 30C50811  
hcr_el2: 8027603B  
sctlr_el2: 30c50811  
hcr_el2: 8027603b  
INFO[1]: loading...  
INFO[1]: loaded  
Kernel process started. EL 1
```

```
User process
```

```
12INFO[2]: loading...  
INFO[2]: loaded  
INFO[3]: loading...  
INFO[3]: loaded  
345123451abcdeabcdeab2345█
```

把引導跟UART的
部分重構後可以
順利的在
RaspVisor上開機
並切換系統

未來展望：

- 多核心效能調度
- 在Raspvisor上執行Linux並進行資料交換
- 移植到其他主控版上進行工作

謝謝大家