Real-Time Operating System (Day 2 Lab)

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09. ButtonISR (06 복사해서 수정)

- bsw.cpp 수정: 버튼 인터럽트 받을 수 있도록
- OIL 수정: ButtonISR 추가

```c
…                                              bsw.c
#include <avr/io.h>
#include <avr/interrupt.h>
…
#define   _BV(bit) (1 << (bit))
int main(void)
{
    PORTC = _BV(PC0);
    PCICR = _BV(PCIE1);
    PCMSK1 = _BV(PCINT8);
    EIFR = 0xff;
    sei();

    init();
```

```
ISR ButtonISR {
    CATEGORY = 2;
    SOURCE = "PCINT1";
};
```
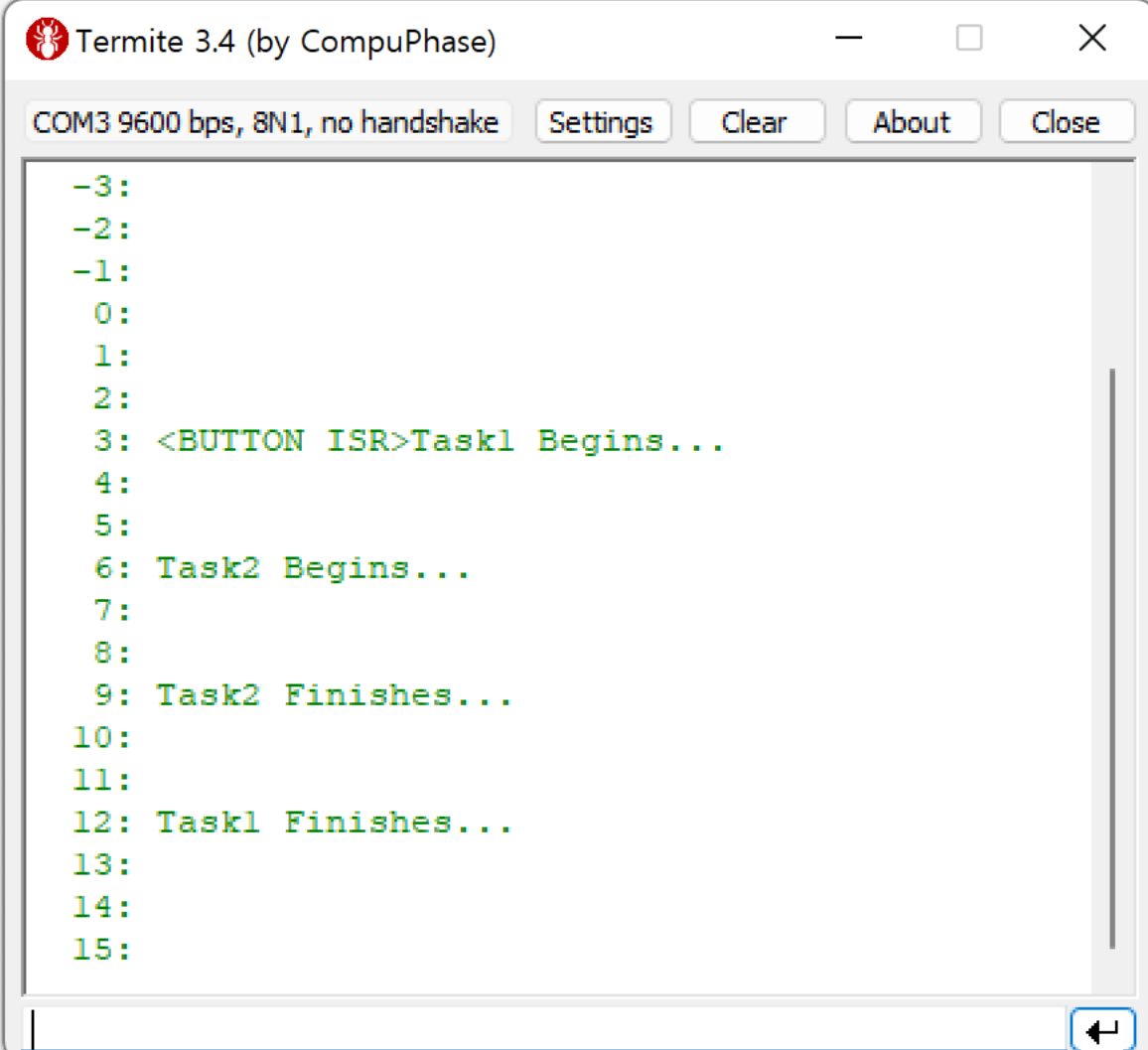
09. ButtonISR

```
ISR2(TimerISR)
{
    static long c = -4;
    if (c == 0)
        ActivateTask(Task1);
    printfSerial("\n%4ld: ", c++);
}
```

```
ISR2(ButtonISR)                          asw.c
{
    int a0;
    DisableAllInterrupts();
    if ((PINC & 0x01) != 0) return;
    printfSerial("<BUTTON ISR>");
    a0 = analogRead(A0); // read ADC value
    if (a0 < 50) { // UP
        ActivateTask(Task1);
    } else if (a0 < 200) { // DOWN
        ActivateTask(Task2);
    } else if (a0 < 380) { // LEFT
        ;
    } else if (a0 < 520) { // RIGHT
        ;
    }
    EnableAllInterrupts();
}
```

09. ButtonISR

- 중복 Activation의 경우?
  - ACTIVATION = 1; 수정 필요

- ISR에서 mdelay 실행하면?

- Nested Interrupt
  - ButtonISR 도중 TimerISR 실행

10. Alarm

- OIL에 COUNTER와 ALARM 추가

```
COUNTER counter1 {
    MINCYCLE = 1;
    MAXALLOWEDVALUE = 127;
    TICKSPERBASE = 1;
};

ALARM alarm1 {
    COUNTER = counter1;
    ACTION = ACTIVATETASK {
        TASK = Task1;
    };
    AUTOSTART = TRUE {
        ALARMTIME = 5;
        CYCLETIME = 10;
    };
};
```

```
ALARM alarm2 {
    COUNTER = counter1;
    ACTION = ACTIVATETASK {
        TASK = Task2;
    };
    AUTOSTART = TRUE {
        ALARMTIME = 5;
        CYCLETIME = 20;
    };
};
```

10. Alarm

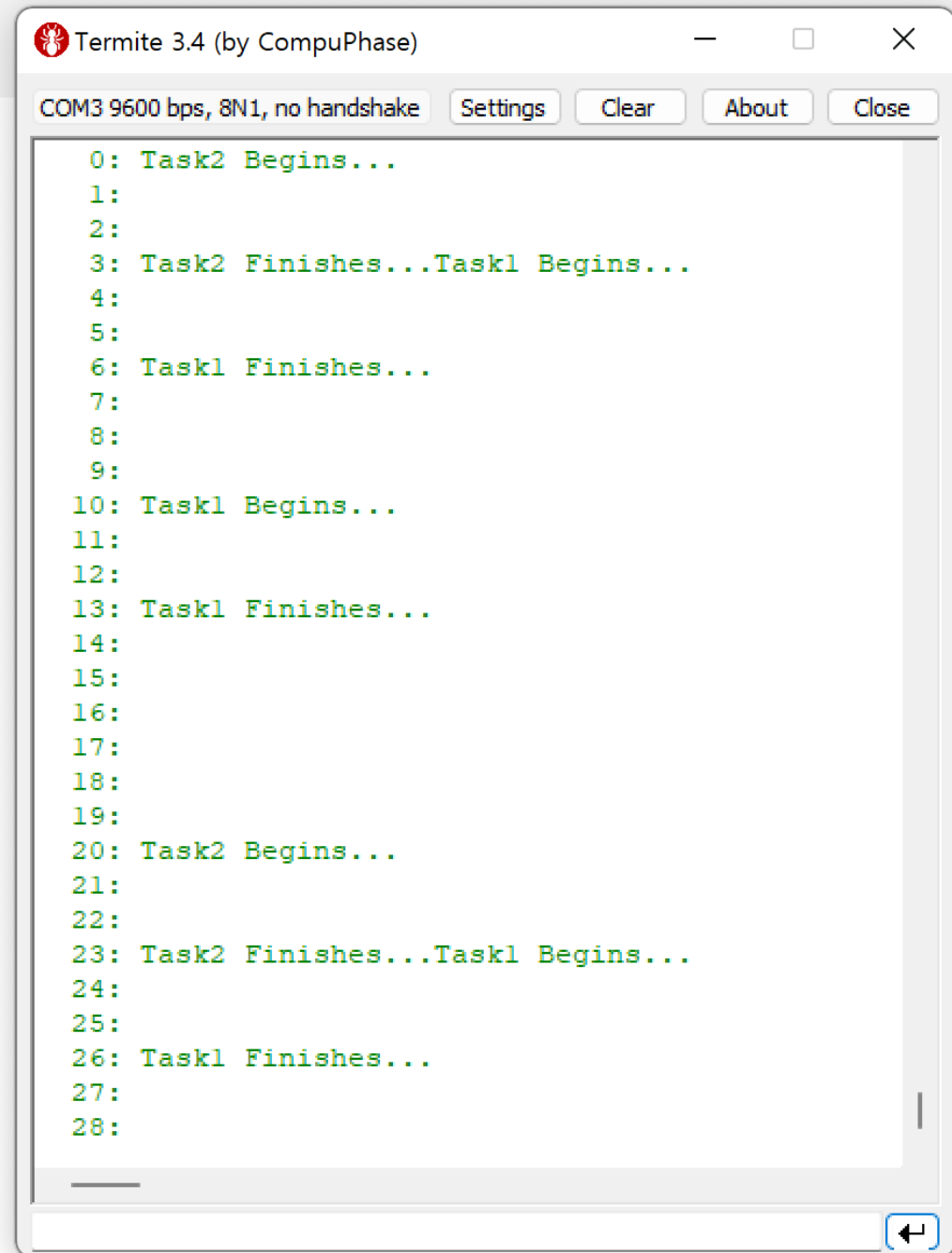- TimerISR에서 counter1 증가

```
ISR2(TimerISR)
{
    static long c = -4;
    IncrementCounter(counter1);
    printfSerial("\n%4ld: ", c++);
}
```

```
TASK(Task1)
{
    printfSerial("Task1 Begins...");
    mdelay(3000);
    printfSerial("Task1 Finishes...");
    TerminateTask();
}

TASK(Task2)
{
    printfSerial("Task2 Begins...");
    mdelay(3000);
    printfSerial("Task2 Finishes...");
    TerminateTask();
}
```

10. Alarm

- Alarm을 이용한 주기적 Task 실행

```
Termite 3.4 (by CompuPhase)                              —  □  X

COM3 9600 bps, 8N1, no handshake    Settings   Clear   About   Close

 0: Task2 Begins...
 1:
 2:
 3: Task2 Finishes...Task1 Begins...
 4:
 5:
 6: Task1 Finishes...
 7:
 8:
 9:
10: Task1 Begins...
11:
12:
13: Task1 Finishes...
14:
15:
16:
17:
18:
19:
20: Task2 Begins...
21:
22:
23: Task2 Finishes...Task1 Begins...
24:
25:
26: Task1 Finishes...
27:
28:
```
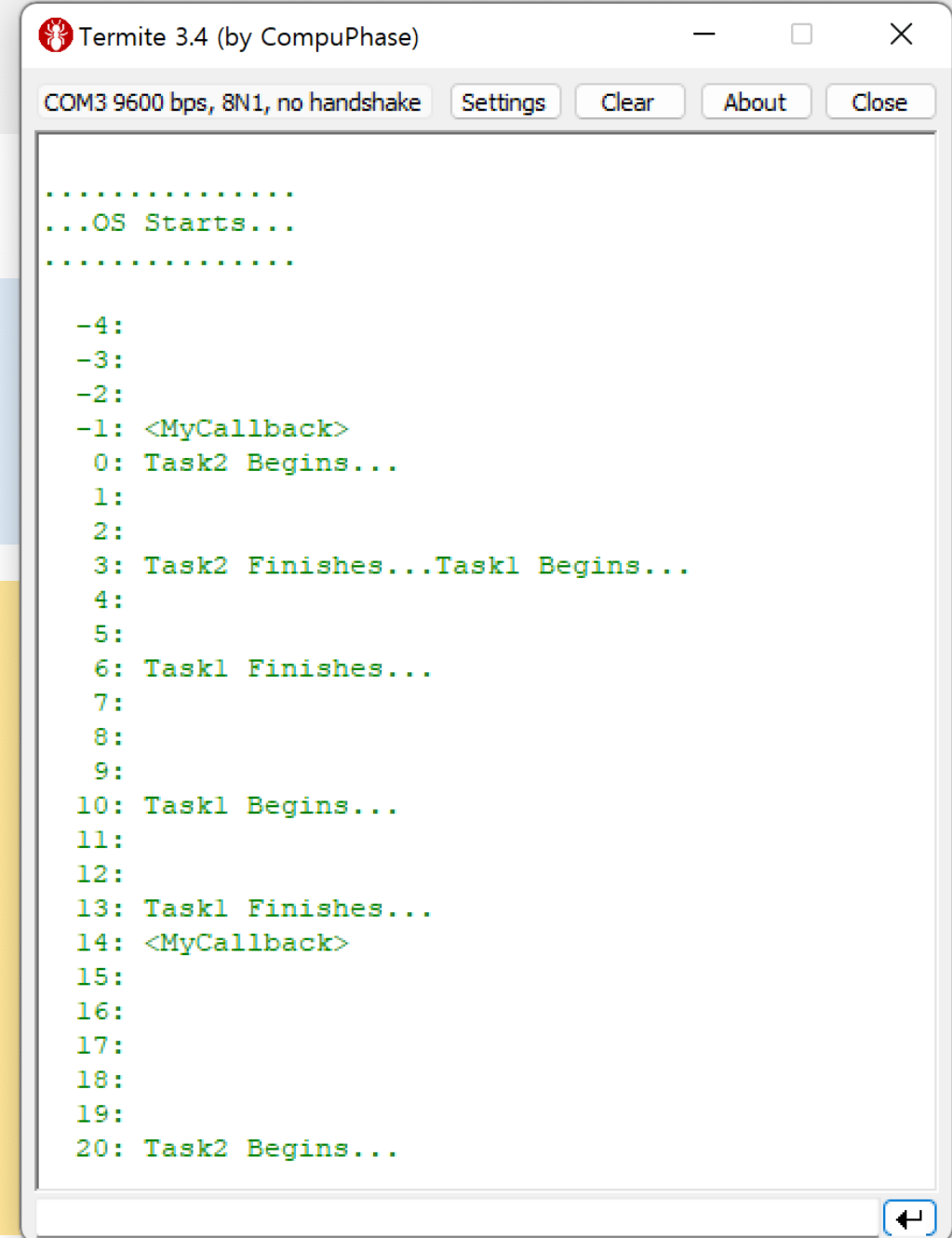
11. Alarm Callback

- 콜백 함수 등록

```
ALARMCALLBACK(MyCallback) {
    printfSerial("MyCallback Begins...");
    printfSerial("MyCallback Finishes...");
}
```

```
ALARM alarm3 {
    COUNTER = counter1;
    ACTION = ALARMCALLBACK {
        ALARMCALLBACKNAME = "MyCallback";
    };
    AUTOSTART = TRUE {
        ALARMTIME = 5;
        CYCLETIME = 15;
    };
};
```

```
Termite 3.4 (by CompuPhase)                    —    □    ✕
COM3 9600 bps, 8N1, no handshake   Settings   Clear   About   Close

...............
...OS Starts...
...............


 -4:
 -3:
 -2:
 -1: <MyCallback>
  0: Task2 Begins...
  1:
  2:
  3: Task2 Finishes...Task1 Begins...
  4:
  5:
  6: Task1 Finishes...
  7:
  8:
  9:
 10: Task1 Begins...
 11:
 12:
 13: Task1 Finishes...
 14: <MyCallback>
 15:
 16:
 17:
 18:
 19:
 20: Task2 Begins...
```

12. Event

```
TASK(Task2)
{
    EventMaskType mask;
    printfSerial("Task2 Begins...");
    printfSerial("Task2 Waits...");
    WaitEvent(Event1 | Event2 | Event3);
    printfSerial("Task2 Wakes Up...");
    GetEvent(Task2, &mask);
    if (mask & Event1) {
        printfSerial("[Event1]");
        ClearEvent(Event1);
    }
    if (mask & Event2) {
        printfSerial("[Event2]");
        ClearEvent(Event2);
    }
    if (mask & Event3) {
        printfSerial("[Event3]");
        ClearEvent(Event3);
    }
    printfSerial("Task2 Finishes...");
    TerminateTask();
}
```
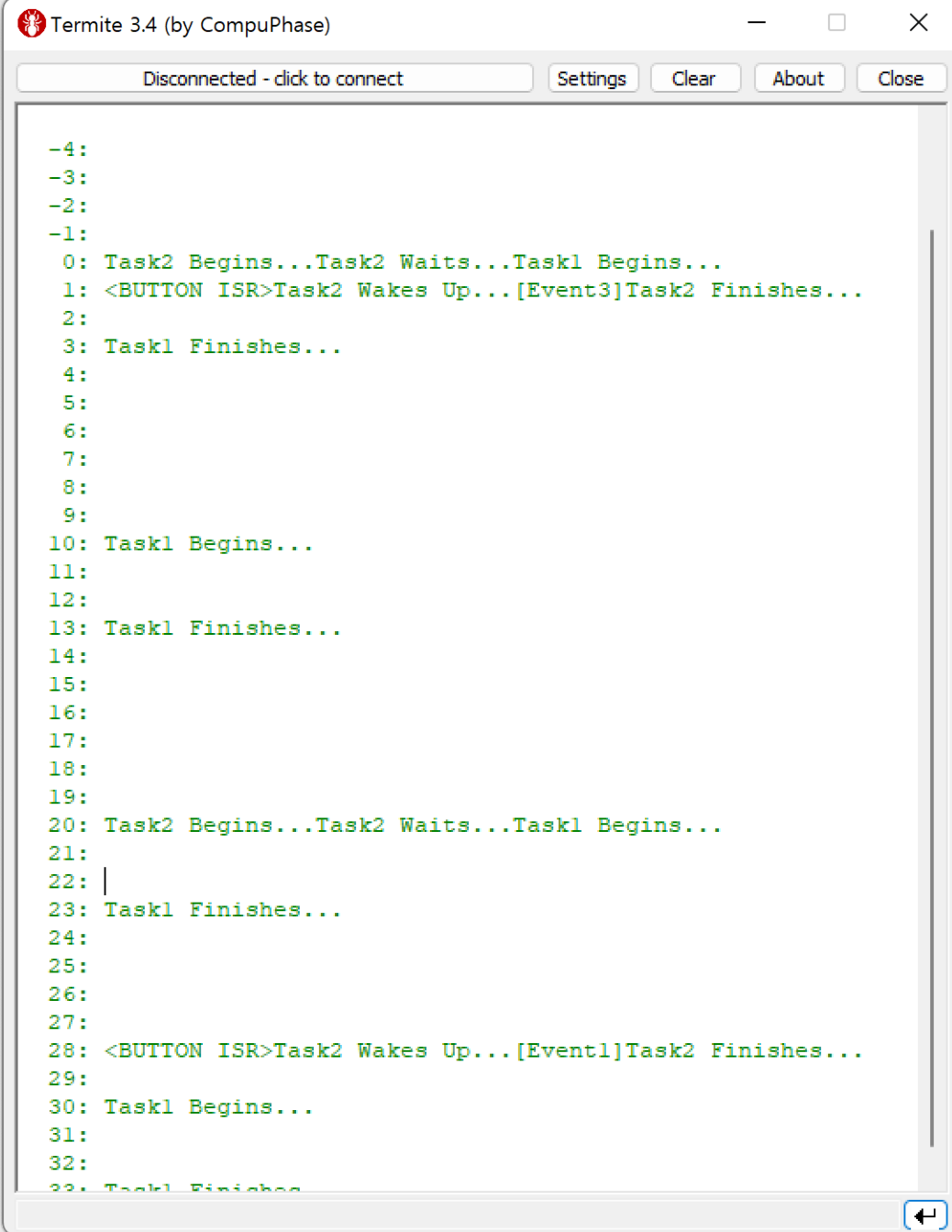
12. Event

```
ISR2(ButtonISR)
{
    int a0;
    DisableAllInterrupts();
    if ((PINC & 0x01) != 0) return;
    printfSerial("<BUTTON ISR>");
    a0 = analogRead(A0); // read ADC value
    if (a0 < 50) { // UP
        SetEvent(Task2, Event1);
    } else if (a0 < 200) { // DOWN
        SetEvent(Task2, Event2);
    } else if (a0 < 380) { // LEFT
        ;
    } else if (a0 < 520) { // RIGHT
        ;
    }
    EnableAllInterrupts();
}
```

```
…
CPU_DATA = AVR8 {
    MULTI_STACK = TRUE;
};
…
EVENT Event1 { MASK = AUTO; };
EVENT Event2 { MASK = AUTO; };
…
TASK Task2 {
    PRIORITY = 2;
    STACK = PRIVATE {
        SIZE = 512;
    };
    SCHEDULE = FULL;
    EVENT = Event1;
    EVENT = Event1;
…
```

12. Event

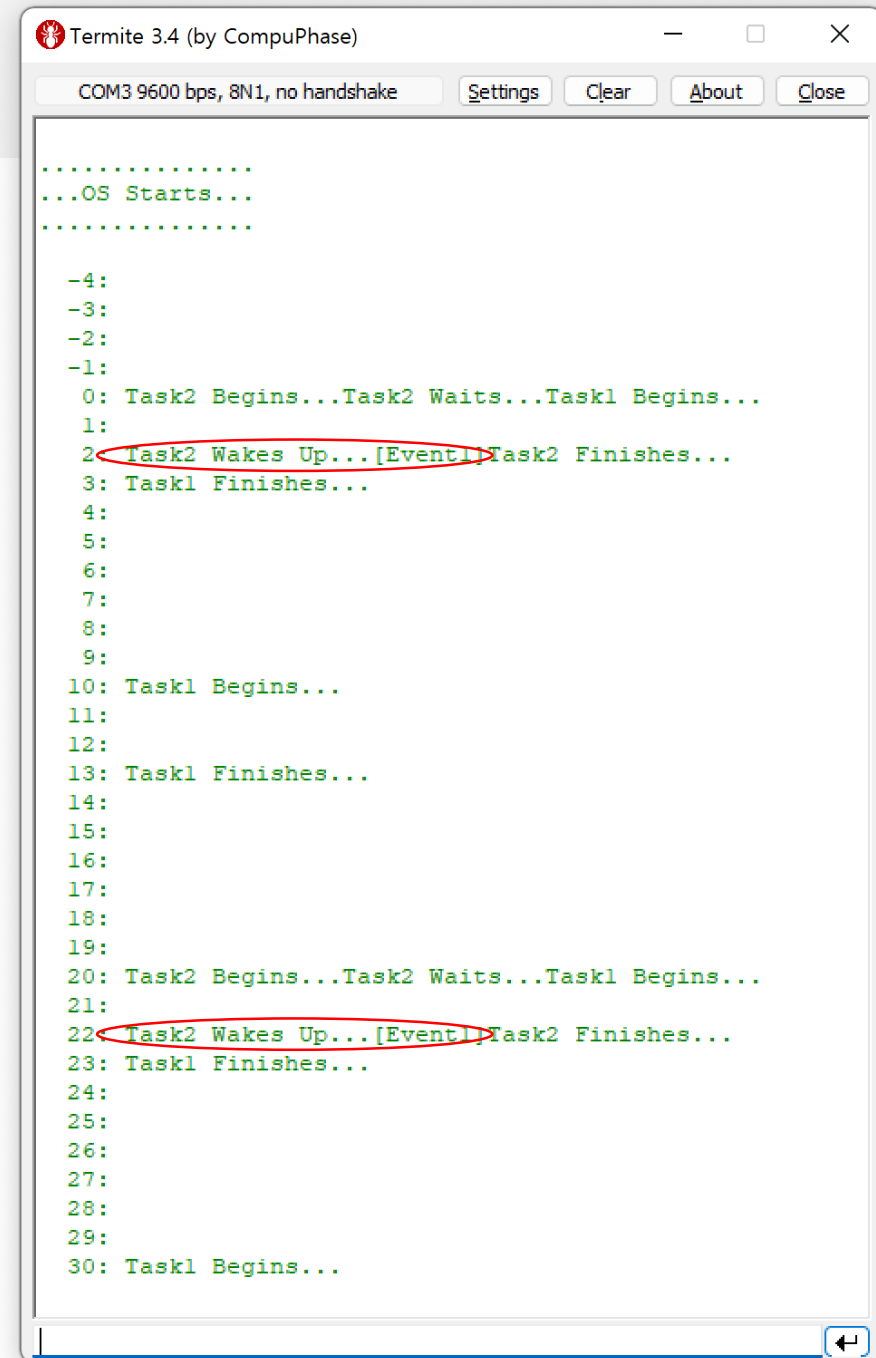- ClearEvent는 왜 필요한가?
- 우선순위 반대의 경우 스케쥴링

Termite 3.4 (by CompuPhase)

Disconnected - click to connect | Settings | Clear | About | Close

```
-4:
-3:
-2:
-1:
 0: Task2 Begins...Task2 Waits...Task1 Begins...
 1: <BUTTON ISR>Task2 Wakes Up...[Event3]Task2 Finishes...
 2:
 3: Task1 Finishes...
 4:
 5:
 6:
 7:
 8:
 9:
10: Task1 Begins...
11:
12:
13: Task1 Finishes...
14:
15:
16:
17:
18:
19:
20: Task2 Begins...Task2 Waits...Task1 Begins...
21:
22: |
23: Task1 Finishes...
24:
25:
26:
27:
28: <BUTTON ISR>Task2 Wakes Up...[Event1]Task2 Finishes...
29:
30: Task1 Begins...
31:
32:
33: Task1 Finishes...
```

13. Alarm SetEVent

- Alarm의 SetEvent Action

```
ALARM alarm3 {
    COUNTER = counter1;
    ACTION = SETEVENT {
        TASK = Task2;
        EVENT = Event1;
    };
    AUTOSTART = TRUE {
        ALARMTIME = 7;
        CYCLETIME = 20;
    };
};
```

14. Hook

- OIL 파일 Hook 설정

- Alarm3 삭제

- 8번 예제의 printState() 추가

```
…
    KERNEL_TYPE = OSEK {
        CLASS = ECC2; // Default
    };
    STARTUPHOOK = TRUE;
    SHUTDOWNHOOK = TRUE;
    PRETASKHOOK = TRUE;
    POSTTASKHOOK = TRUE;
};
…
```

14. Hook

- Task2 변경
- 8번 예제의 printState() 사용. 추가

```
TASK(Task2)
{
    printfSerial("Task2 Begins...");
    mdelay(3000);
    printfSerial("Task2 Finishes...");
    TerminateTask();
}
```

14. Hook

- StartupHook
- ShutdownHook

```c
void StartupHook(void)
{
    printfSerial("..StartupHook..\n");
}


void ShutdownHook(StatusType Error)
{
    printfSerial("ShutdownHook...\n");
    printState(Task1);
    printState(Task2);
}
```
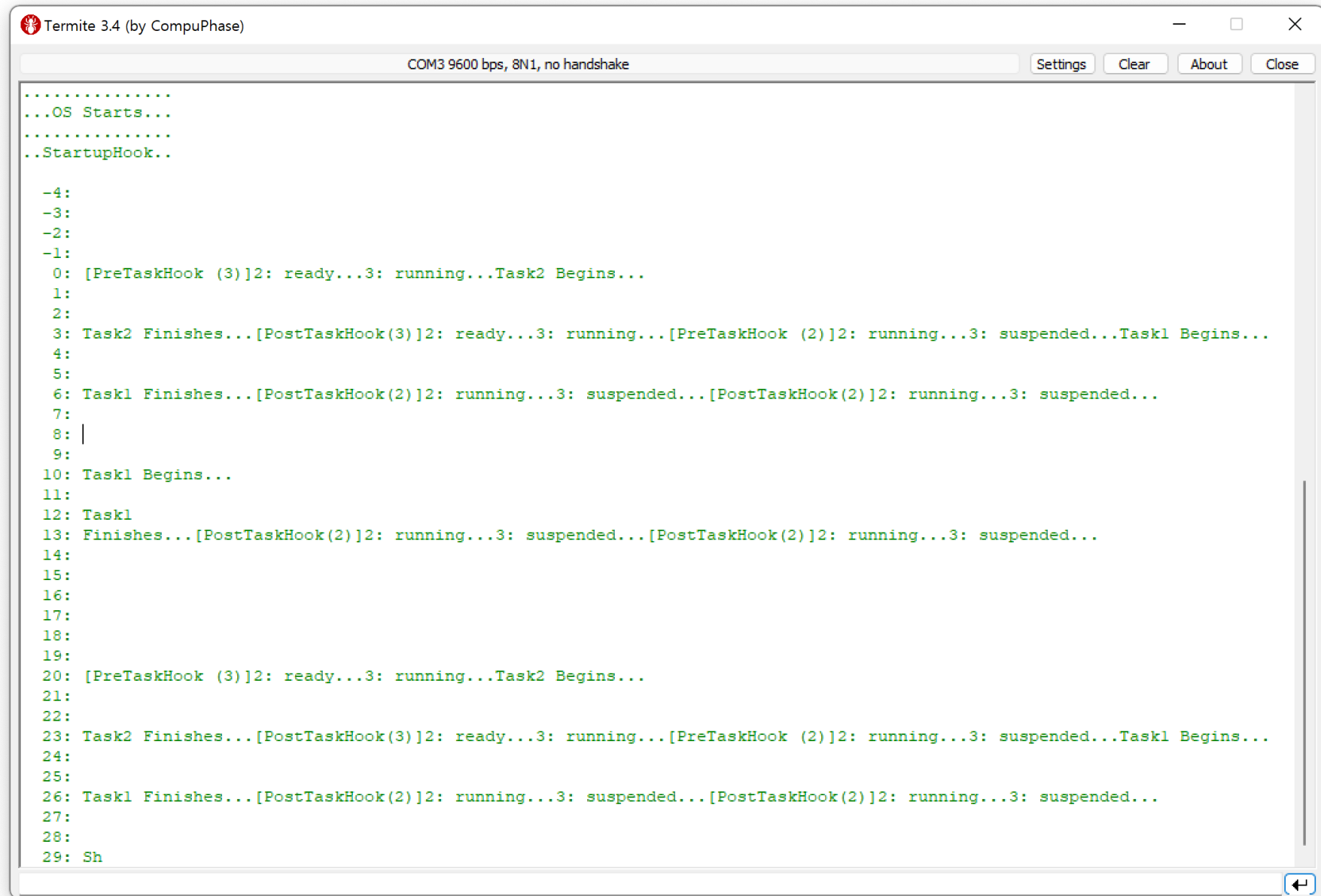
14. Hook

- PreTaskHook
- PostTaskHook

```c
void PreTaskHook(void)
{
    TaskType id;
    GetTaskID(&id);
    printfSerial("[PreTaskHook(%d)]", id);
    printState(Task1);
    printState(Task2);
}

void PostTaskHook(void)
{
    TaskType id;
    GetTaskID(&id);
    printfSerial("[PostTaskHook(%d)]", id);
    printState(Task1);
    printState(Task2);
}
```

14. Hook


```
...............
...OS Starts...
...............
..StartupHook..

 -4:
 -3:
 -2:
 -1:
  0: [PreTaskHook (3)]2: ready...3: running...Task2 Begins...
  1:
  2:
  3: Task2 Finishes...[PostTaskHook(3)]2: ready...3: running...[PreTaskHook (2)]2: running...3: suspended...Task1 Begins...
  4:
  5:
  6: Task1 Finishes...[PostTaskHook(2)]2: running...3: suspended...[PostTaskHook(2)]2: running...3: suspended...
  7:
  8: |
  9:
 10: Task1 Begins...
 11:
 12: Task1
 13: Finishes...[PostTaskHook(2)]2: running...3: suspended...[PostTaskHook(2)]2: running...3: suspended...
 14:
 15:
 16:
 17:
 18:
 19:
 20: [PreTaskHook (3)]2: ready...3: running...Task2 Begins...
 21:
 22:
 23: Task2 Finishes...[PostTaskHook(3)]2: ready...3: running...[PreTaskHook (2)]2: running...3: suspended...Task1 Begins...
 24:
 25:
 26: Task1 Finishes...[PostTaskHook(2)]2: running...3: suspended...[PostTaskHook(2)]2: running...3: suspended...
 27:
 28:
 29: Sh
```

15. Error Handling

• OIL 파일 설정

오류가 발생한 Service ID와
Parameter 정보 접근

```
…
    KERNEL_TYPE = OSEK {
        CLASS = ECC2; // Default
    };
    STARTUPHOOK = FALSE;
    SHUTDOWNHOOK = FALSE;
    PRETASKHOOK = FALSE;
    POSTTASKHOOK = FALSE;
    ERRORHOOK = TRUE;
    USEGETSERVICEID = TRUE;
    USEPARAMETERACCESS = TRUE;
};
…
```

15. Error Handling

```
ISR2(TimerISR)
{

    static long c = -4;
    TaskStateType s;
    if (c == 5) {
        GetTaskState(30, &s);
    }
    IncrementCounter(counter1);
    printfSerial("\n%4ld: ", c++);
}

void ErrorHook(StatusType error)
{
    printfSerial("[ErrorHook: error = %d, service = %d, TaskID = %d]",
        error,
        OSErrorGetServiceId(),
        OSError_GetTaskState_TaskID());
}
```

Parameter 정보 접근 매크로
(ee_oo_api_osek.h)

15. Error Handling

```
E_OK,                  /* ((StatusType)0)  */
E_OS_ACCESS,           /* ((StatusType)1)  */
E_OS_CALLEVEL,         /* ((StatusType)2)  */
E_OS_ID,               /* ((StatusType)3)  */
E_OS_LIMIT,            /* ((StatusType)4)  */
E_OS_NOFUNC,           /* ((StatusType)5)  */
E_OS_RESOURCE,         /* ((StatusType)6)  */
E_OS_STATE,            /* ((StatusType)7)  */
E_OS_VALUE,            /* ((StatusType)8)  */
E_OS_SERVICEID,        /* ((StatusType)9)  */
E_OS_ILLEGAL_ADDRESS,  /* ((StatusType)10) */
…
```

ee_api_types.h

```
OSServiceId_ActivateTask        = (0),
OSServiceId_TerminateTask       = (2),
OSServiceId_ChainTask           = (4),
OSServiceId_Schedule            = (6),
OSServiceId_GetTaskID           = (8),
OSServiceId_GetTaskState        = (10)
,
OSServiceId_DisableAllInterrupts = (12)
,
OSServiceId_EnableAllInterrupts  = (14)
,
OSServiceId_SuspendAllInterrupts = (16)
,
OSServiceId_ResumeAllInterrupts  = (18)
,
OSServiceId_SuspendOSInterrupts  = (20)
,
OSServiceId_ResumeOSInterrupts   = (22)
,
…
```

15. Error Handling

```
/**
 *  \brief This macro returns the TaskID parameter passed to ActivateTask().
 *  \ingroup primitives-hook
 */
#define OSError_ActivateTask_TaskID()\
  ((TaskType)osEE_get_api_param1().num_param)

/**
 *  \brief This macro returns the TaskID parameter passed to ChainTask().
 *  \ingroup primitives-hook
 */
#define OSError_ChainTask_TaskID()\
  ((TaskType)osEE_get_api_param1().num_param)

/**
 *  \brief This macro returns the TaskID parameter passed to GetTaskID().
 *  \ingroup primitives-hook
 */
#define OSError_GetTaskID_TaskID()\
  ((TaskRefType)osEE_get_api_param1().p_param)
```
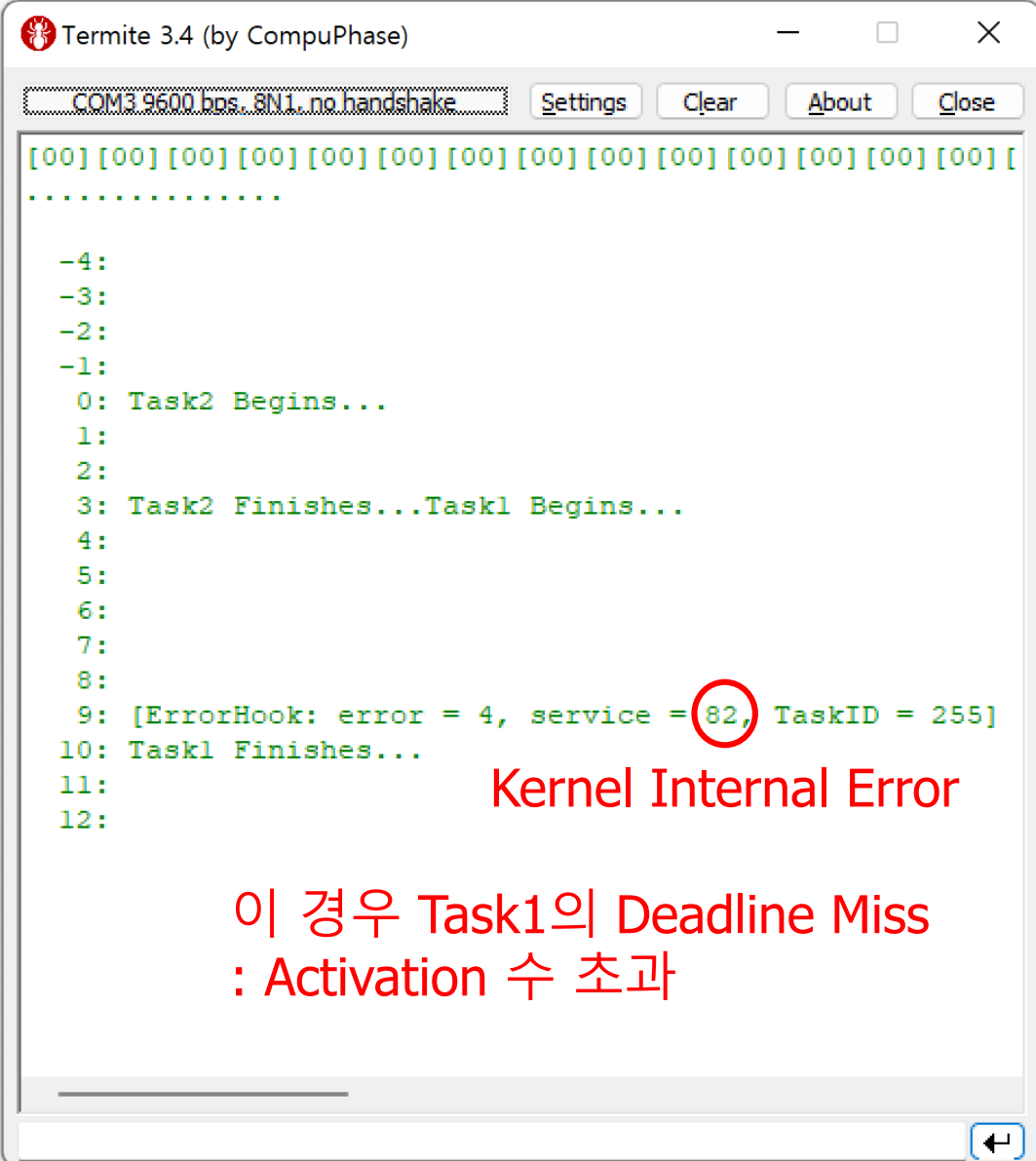
ee_oo_api_osek.h

16. Deadline Miss

```c
ISR2(TimerISR)
{
    static long c = -4;

    IncrementCounter(counter1);
    printfSerial("\n%4ld: ", c++);
}

TASK(Task1)
{
    TaskType id;
    printfSerial("Task1 Begins...");
    mdelay(7000);
    printfSerial("Task1 Finishes...");
    TerminateTask();
}
```

Termite 3.4 (by CompuPhase)

COM3 9600 bps, 8N1, no handshake   Settings | Clear | About | Close

```
[00][00][00][00][00][00][00][00][00][00][00][00][00][00][
.............

 -4:
 -3:
 -2:
 -1:
  0: Task2 Begins...
  1:
  2:
  3: Task2 Finishes...Task1 Begins...
  4:
  5:
  6:
  7:
  8:
  9: [ErrorHook: error = 4, service = 82, TaskID = 255]
 10: Task1 Finishes...
 11:
 12:
```

Kernel Internal Error

이 경우 Task1의 Deadline Miss
: Activation 수 초과

Questions